

# **Radiation Safety Manual**

THE UNIVERSITY OF  
**MEMPHIS**<sup>®</sup>

## **Notice To Users**

This Radiation Safety Manual, approved by The University of Memphis Radiation Safety Committee on March 27, 1996, and updated on July 12, 2010, represents official University policy on radiation and radioactive material. As part of the radioactive material licenses for University departments, violations of policies and procedures contained herein are citable as areas of non-compliance by the Tennessee Department of Environment and Conservation - Division of Radiological Health.

Copies of this manual and regulations cited herein are available for viewing during regular business hours in the office of the Radiation Safety Officer and in affected departments.

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# **The University of Memphis**

## **Radiation Safety Program**

The University of Memphis operates under regulations promulgated by the Tennessee Department of Environment and Conservation - Division of Radiological Health and the United States Nuclear Regulatory Commission. These regulations are contained in "State Regulations for Protection Against Radiation" and in Title 10 of the Code of Federal Regulations. Through this manual and other methods, the University establishes policies and procedures designed to encourage regulatory compliance, assure safe use of radiation producing devices and radioactive materials, and maintain radiation exposure to personnel as low as reasonably achievable (ALARA). All personnel using radiation sources are expected to be familiar with and operate within the policies and procedures contained in this manual.

### **Radiation Safety Committee**

The Radiation Safety Committee (RSC) governs the possession and use of radioactive materials and other sources of radiation at The University of Memphis. Committee members are appointed by the President of the University on the basis of their knowledge and experience with radiation and radioactive materials.

The Radiation Safety Committee must prepare, or cause to be prepared, a radiation safety manual which delineates policies, procedures, and control measures for the possession and use of radioactive materials and radiation producing devices. The goal of these measures should be to minimize exposure of personnel to radiation.

- The Radiation Safety Committee should receive and review reports from the Radiation Safety Office, and other sources, on:
- Proposed changes to procedures, equipment, or systems as required in this manual;
- Tests or experiments not previously reviewed and approved by the Committee;
- Violations of applicable statutes, codes, regulations, technical specifications, license requirements, internal procedures and instructions; and
- Radiological events which have been reported to the U.S. Nuclear Regulatory Commission or Tennessee Division of Radiological Health.

The Committee will serve in an advisory capacity to the President of the University in matters related to safety and health of personnel, and for the acquisition, use, and

distribution of radioactive materials and radiation producing devices at The University of Memphis. All reports to the President shall be submitted by the chair of the committee.

The Radiation Safety Committee shall meet at least quarterly, but more often if necessary, to perform reviews and audits outlined in this manual, prepare periodic reports for the President, and execute other related duties.

The Radiation Safety Officer should serve as secretary to the Committee, and be responsible for and have authority to perform duties and functions outlined in this manual. If qualified, the Radiation Safety Officer may serve as chair, but must submit to an annual audit by the Committee.

### **Radiation Safety Officer**

The Radiation Safety Officer (RSO) is the chief administrative officer of the radiation safety program, operating under supervision of the Radiation Safety Committee. The RSO shall:

Prepare and maintain a Radiation Safety Manual for the University;

- Establish and administer a radiation dosimetry program, including a record keeping system, issuing and processing of personnel dosimeters, notifying individuals of exposures at least annually and more frequently when warranted;
- Establish procedures for, and cause to be made, periodic surveys of areas where radioactive materials are used or stored;
- Submit necessary documents (with the cooperation of affected departments) for licensing of radioactive materials and registration of radiation producing devices;
- Develop and administer a calibration program for survey instruments;
- Prepare and present briefings and training sessions for University personnel and others who might use or be exposed to radiation;
- Maintain a Radiation Safety Office which may be contacted 24 hours per day each day of the week in the event of accident or other abnormal occurrence;
- Review and approve procedures and documents requiring the attention of the Radiation Safety Officer prior to implementation by University departments;
- Encourage compliance with procedures outlined in this Manual and with regulations of appropriate government agencies; and
- Audit, as appropriate, records of possession and use of radioactive materials and radiation producing devices. Such audits should include a review of departmental procedures, manuals, logs, emergency plans, and other documents relevant to compliance with applicable standards.

## **User Categories**

### *Responsible User*

A Responsible User (RU) is qualified by training and experience to supervise the use of radioactive materials or radiation producing devices at The University of Memphis. Generally a member of the faculty or staff, Responsible Users bear primary responsibility for the proper use and storage of radioactive materials or the use of radiation producing devices under their supervision. Within a department, laboratory, or other unit, only the RU may initiate the transfer or purchase of radioactive materials. Requests for designation as an RU should be submitted to the Radiation Safety Officer. Responsible Users of radioactive materials are approved by the Tennessee Division of Radiological Health and are listed by name in the appropriate radioactive material licenses. Department Chairs and RU's are responsible for notifying the RSO upon termination of association with The University of Memphis.

### *Authorized User*

An Authorized User (AU) works under the supervision of the Responsible User and is certified as a radiation worker by the Radiation Safety Officer. Such certification is normally granted through successful completion of training conducted by the RSO or a designated representative. Successful completion of training will be based upon a minimum score of 70% on an examination consisting of at least ten (10) questions. The RSO may grant exemptions from the training requirement for persons submitting satisfactory evidence of previous training and/or experience; however, those requesting exemption from training may be required to pass an examination equivalent to that given at the end of training. Additional training may be required by the RSO when individuals use or desire to use radioactive materials in large quantities, radiation sources for which there are extraordinary hazards or special operating procedures, and when required by license agreement.

### *Non-User*

A Non-User is one who might work near an area where radiation sources are used or stored but does not work in restricted areas or use radioactive materials. Such a person should complete a brief (up to one hour) informational session conducted by the RSO or a designee.

## **Radiation Producing Devices**

No person or group shall purchase or otherwise possess on University property any radiation producing device without the written consent of the RSO or RSC unless such device is specifically exempted from registration with the Tennessee Division of

Radiological Health (DRH). Non-exempt radiation producing devices shall be registered with DRH and shall be inspected annually or at other intervals as directed by regulations and the RSO.

All safety devices such as interlocks, shutters, and warning lights on radiation producing devices shall be tested by the using department at intervals not to exceed three (3) months; records of these tests shall be maintained for inspection by DRH and the RSO.

Operation of radiation producing devices shall be limited to personnel with training and experience considered acceptable by the RSO. Personnel using radiation producing devices on human subjects shall hold an acceptable certification by the State Board of Medical Examiners or other accreditation body acceptable to DRH.

### **Industrial Radiography**

Departments intending to engage in industrial radiography shall contact the RSO well in advance of such operations and shall follow regulations found in Chapter 1200-2-8, Radiation Safety Requirements for Industrial Radiography Operations, as found in "State Regulations for Protection Against Radiation." Those planning industrial radiography operations should be prepared financially to support these additional regulatory requirements.

### **Use of Radioactive Materials for Experimental Purposes**

Laboratory procedures involving radioisotopes must be done or directly supervised by a Responsible User. Experiments involving radioisotopes in quantities greater than two (2) times those specified in Schedule RHS 8-31 require prior approval of the Radiation Safety Committee for each new experiment. However, an approved procedure may be repeated without additional approval provided the amount of radioactive material is not increased more than 25% above the authorized amount. In the case of continuous or repeated use of an isotope for an approved procedure, the quantity used weekly will be subject to the above limits provided the total quantity involved in the experiment at one time is not more than 25% above the authorized amount and the total quantity possessed (including stored waste) does not exceed the licensed limit.

Requests for approval of experimental procedures should be made in the form of a letter or memo to the RSO for submission to the RSC. Requests should clearly state:

- The individual who will direct the experiment and be responsible for the radioactive material involved;

- The names of all individuals who will work with or be in the presence of the materials;
- The qualifications of all individuals involved, including training and experience in handling radioactive materials;
- The isotopes and quantities involved;
- A brief description of the experiment with an analysis of the radiation hazards involved, including external exposure, absorption, ingestion, and inhalation;
- A description of the facility where the experiment will be performed; and
- A description of any special precautions that will be taken to insure that radiation exposures to individuals are kept as low as reasonably achievable.

### **Procedure for Obtaining Radioactive Materials**

Radioactive materials may be purchased or obtained by any department or unit of the University subject to the conditions listed below:

- The department or unit shall be licensed by the Tennessee Division of Radiological Health for possession of the desired isotope.
- Prior approval of the Radiation Safety Office shall be obtained before purchasing or bringing onto The U of M campus any radioactive materials.
- The individual purchasing or obtaining radioactive materials for use on The U of M campus or any other area controlled by The U of M shall be licensed to use the materials by the Tennessee Division of Radiological Health. That individual, designated the Responsible User, will be the person held accountable for the material until it is transferred to another Responsible User who can legally accept it or until it is properly disposed of. All transfers shall be reported to the RSO.

The Chair of each licensed department shall be responsible for assuring that quantities possessed at any one time do not exceed those authorized on the appropriate radioactive material license. Where multiple departments operate under one license, the chair or director of the department with the majority of users shall be responsible for the functions set forth above unless alternate arrangements are agreed to by the RSO or RSC.

### **Procedure for Receiving Radioactive Materials**

Radioactive materials are to be shipped to and received in a timely manner by a qualified individual in the ordering department or unit. Within three (3) hours of receipt, each package should be examined as follows:

- The package shall not show visible signs of leakage or physical damage which could release radioactive contaminants.
- The surface of a package containing gamma or neutron emitting radioisotopes shall be monitored for radiation, and levels in excess of 200 millirem/hour must be reported to the Radiation Safety Office.
- The surface of a package containing alpha or beta emitters shall be checked for removable contamination by use of a wipe test. Removable contamination in excess of 0.01 microcurie (22,200 dpm) per 100 square centimeters must be reported to the Radiation Safety Office.
- Packages not failing the above criteria may be opened, the contents verified against the packing slip and original order, and inner container examined for integrity.
- In the event that a received package fails any of the above criteria, steps shall be taken immediately to prevent the spread of contamination and to remediate existing problems.

Where surface contamination or external radiation levels exceed the above limits, the RSO or a designated representative shall notify the final delivery carrier and the Tennessee Division of Radiological Health in accordance with 1200-2-5-.115.

Prior to disposal, empty packing materials shall be surveyed. Materials found to be contaminated must be handled as radioactive waste; non-contaminated packing may be disposed of as normal solid waste after radiation labels and markings are obliterated.

Departments receiving radioactive materials shall maintain complete records on all shipments received, including survey results, with copies to the Radiation Safety Office. A suggested form is included with this manual.

## **Transportation of Radioactive Materials**

Transportation of radioactive materials by University personnel shall be done in accordance with state and federal regulations, including packing, manifesting, placarding of vehicles, and associated items addressed in Title 49 of the Code of Federal Regulations.

## **Inventories**

Responsible Users, or the Department Chair in the absence of an RU, shall perform a semi-annual physical inventory of all radioactive materials under their control.

Inventories shall be retained within the department with copies forwarded to the RSO in a timely fashion.

## **Emergency Procedures**

Each area containing radioisotopes in liquid form must conspicuously post a spill control procedure and have a readily accessible spill control kit which includes vermiculite, absorbents, or other material suitable for diking and absorbing spills, a chemical resistant container for holding waste, appropriate personal protective equipment, and materials such as sodium bicarbonate or citric acid (when appropriate) for neutralizing spills.

In the event of a spill or other accident involving radiation or radioactive materials, the following procedures should be followed in addition to guidance provided in the posted spill control procedure.

### *Minor Spills or Contamination of Surfaces*

The Laboratory supervisor will notify all personnel in the vicinity immediately.

The extent of contamination will be determined and appropriate measures taken to prevent further spread.

Individuals in the room or area who might be contaminated will be checked and instructed to change clothing and wash affected areas if necessary.

Contaminated surfaces will be cleaned by laboratory personnel.

A report will be made to the Radiation Safety Officer.

### *Major Spills Involving Radiation Hazard to Personnel*

The laboratory supervisor or other person in charge of the laboratory will take charge of the emergency.

All personnel in the room or area will be notified to vacate immediately.

Any action that can be taken immediately to prevent the spread of contamination such as closing doors, shutting off ventilating systems, spreading absorbent material, etc.,

will be taken provided such action does not cause excess radiation exposure or other danger to individuals involved.

The person in charge will notify the Radiation Safety Officer at 678-4672, or the University Public Safety Department (678-HELP) if the accident occurs during other than normal working hours.

Individuals involved will be checked for contamination and instructed to change clothing and wash affected areas if necessary.

If there are injuries requiring medical attention, the University Health Center will be notified and

if necessary the victim(s) will be transported to the Regional Medical Center at Memphis by Memphis Fire Department Ambulance Service.

Contaminated areas will be defined and posted.

A clean-up plan will be devised and decontamination will proceed as soon as practicable.

An investigation will be made by the RSO and/or the Radiation Safety Committee.

#### *Accidents Involving the Release of Airborne Radioactive Materials*

All personnel will be notified to vacate the area.

All fans and ventilating systems will be shut down, and the individual in charge will, if possible, secure all doors and vents and attempt to isolate and seal the area.

Individuals involved will be checked for contamination and instructed to change clothing and wash affected areas if necessary.

The individual in charge will notify the Radiation Safety Office (678-4672) or the University Public Safety Department (678-HELP).

The hazard will be evaluated and equipment necessary for safe re-entry will be obtained.

The area will be surveyed and decontamination will be performed as soon as practicable.

### *Accidents Involving Possible Overexposure of Personnel*

All accidents involving the possible overexposure of personnel must be reported to the Radiation Safety Officer immediately. Operations related to the possible overexposure must be suspended until authorized to resume by the RSO or Radiation Safety Committee.

### *Follow-up Procedures for All Incidents*

A report will be made to the Radiation Safety Officer by the laboratory supervisor. Except for very minor incidents, an investigation will be conducted by the RSO and/or RSC. The RSC will determine what actions are necessary or desirable to prevent further occurrences. Where required, a report will be submitted to appropriate regulatory agencies by the RSO.

If there is a possibility that any individual has ingested or inhaled radioactive material, procedures will be initiated to determine the extent of internal contamination and the radiation dose received. Procedures such as urine or fecal counts may be done locally under supervision of the RSO. If additional procedures such as whole-body counting are required, the individual will be transported to a facility capable of the required procedure. Medical assistance will be obtained if necessary.

All clean-up work will be done in a manner that will minimize the exposure of personnel and spread of contamination. Any release of radioactive material during clean-up will conform to regulatory requirements.

## **Radiation Exposure Limits**

### *Exposure to the Public*

All operations involving radiation shall be conducted so that radiation levels in unrestricted areas will not result in a total effective dose in excess of 0.1 rem in a year or 0.002 rem in any one hour to members of the public. The RSO can provide special monitoring to assure that these limits are not being exceeded. Once monitoring has been accomplished and facilities found to be acceptable, it is the responsibility of affected departments to notify the RSO of any changes to facilities which could change exposure levels to the general public.

### *Exposure of Minors*

No individual under 18 years of age shall be permitted to receive a dose exceeding ten (10) percent of that noted for occupational exposure.

### *Occupational Exposure*

The maximum radiation dose to any individual at The University of Memphis may not exceed the following values without prior approval of the appropriate department chair and RSO or RSC:

<b>Organ</b>	<b>Calendar Quarter</b>
Lens of the Eye	3.75 rems
Skin or Extremities	12.5 rems
Internal Organs (including whole body dose)	12.5 rems
Whole Body	1.25 rems

### *Prenatal Exposure*

Occupational radiation dose to the embryo/fetus shall not exceed 0.5 rem during the entire pregnancy with no more than 0.05 rem permitted in any one month. The dose to an embryo/fetus shall be taken as the sum of the deep-dose equivalent to the declared pregnant woman and the dose to the embryo/fetus due to radionuclides in the embryo/fetus and in the declared pregnant woman. To assure early implementation of dose monitoring for the fetus, it is the responsibility of the pregnant worker to advise the RSO of the pregnancy at the earliest possible date.

### **Airborne Contamination**

Concentrations of airborne radionuclides shall be limited, so far as practicable, by use of engineering and process controls. Departments which use unsealed sources are responsible for evaluating air emissions on an annual basis under provisions of the Clean Air Act. Where emissions warrant, a report shall be filed by such departments

with the U.S. Environmental Protection Agency in accordance with regulations. Annual updates to air emission evaluations shall be filed with the RSO.

### *Engineering Controls*

Fume hoods are essential to minimizing airborne contamination; however, the use of fume hoods shall be limited to units which meet current safety acceptance criteria as adopted by the University

Environmental Health and Safety Office. Proper operation shall be documented on inspection stickers affixed to each fume hood. All newly constructed fume hoods shall include a stack extending at least seven (7) feet above the roof, and shall have no weather cap or other obstruction which would interfere with the vertical discharge of contaminants. Where possible, fume hoods should be equipped with an appropriate filter and manometer. In situations such as iodinations which could release radioactive material in excess of limits found in Schedule RHS 8-30, Table 2, without a filter, iodination cabinets or other secondary means of containment shall be used to assure that stack emissions are below said limits. Biological safety cabinets are generally unsuitable for use with volatile radioactive materials.

### *Work Practices*

Where the potential exists for the release of volatile materials or the creation of aerosols, mists, fumes, dusts, etc., containing radioisotopes, work shall be performed in a qualified fume hood, or within other apparatus capable of isolating the material. For iodinations work practices might also include maintaining iodination solutions at a pH of 9 or greater, using non-oxidative processes when possible, etc. Where tritium labeled sodium borohydride is used, care should be taken to perform all work, including unpacking, in a suitable fume hood, covering containers tightly when not in a fume hood, and acidifying wastes. Where S-35 labeled amino acid solutions are used, care should be taken to absorb or exhaust volatile radioactive compounds released during radiolytic decay - such compounds may contaminate entire incubators and other equipment.

### *Other Methods*

When engineering and process control methods are not practicable to reduce levels below those which define an airborne radioactivity area as found in Tennessee Rule

1200-2-5-.32, one or more of the following methods shall be used to maintain total effective dose as low as reasonably achievable: control of access, limitation of exposure time, use of respiratory protection, or other controls. Respirators shall be selected and used in accordance with a written respirator program, 1200-2-5-.52, 1200-2-5-.91, 1200-2-5-.92, and 1200-2-5.93.

## **Personnel Dosimetry**

### *External Monitoring*

Personnel monitoring devices (dosimeters) shall be worn by individuals likely to receive a dose in excess of 10 percent of applicable limits as noted in the following table, or who enter a high or very high radiation area. Minors and declared pregnant women likely to receive a dose in excess of 5 percent of these limits shall be supplied with dosimeters.

Body badges and/or finger rings are issued by, and returned to, the Radiation Safety Officer on a periodic basis (generally monthly). Rings are normally required only for those whose hands are placed in close proximity to radiation sources. When entering areas where indeterminate radiation levels are suspected, individuals may also be required to wear a temporary, direct reading pocket dosimeter issued by the RSO.

Responsible Users must notify the Radiation Safety Office when individuals under their supervision are in need of monitoring. Dosimetry service is continued until termination is requested by the RU.

When not in use, personnel dosimeters should be stored in areas away from radiation sources, excessive heat, and moisture. A personnel dosimeter should never be deliberately exposed to radiation or worn during non-occupational radiation exposure (e.g., medical or dental x-rays).

### *Bioassays*

Bioassays may be required for personnel handling or using unsealed radioactive sources, and are required for adults likely to receive an annual intake in excess of 10 percent of the applicable annual intake limits found in Table 1, Columns 1 and 2 of Schedule RHS 8-30. Minors and declared pregnant women likely to receive an annual committed effective dose equivalent in excess of 10 percent of any limits in Tennessee Rule 1200-2-5-.55 and 122-2-5-.56 may be required to submit to bioassays.

Individuals working with ten (10) or more millicuries of tritium, carbon-14, phosphorus-32, sulfur-35, and other beta-emitting isotopes per month should submit urine samples

for counting within 24 to 48 hours after a single large procedure, following a spill, at monthly intervals for continuing operations, or upon request of the RSO. Those routinely working with one (1) or more millicuries of tritiated nucleic acids and precursors (thymidine, guanosine, adenosine, cytidine, and phosphorylated derivatives) should submit a urine sample every other month.

Individuals using more than one (1) millicurie of radioiodine per month in unsealed form should submit to a thyroid count monthly, or at other intervals when deemed appropriate for the particular isotope and procedure. Thyroid counts should be performed within seventy-two (72) hours, but no sooner than six (6) hours, after working with unsealed sources of radioiodine.

Occupational radiation exposure records, including bioassay results, shall be maintained in the Radiation Safety Office.

## **Surveys**

Each Responsible User, or Department Chair in the absence of an RU, shall make or cause to be made periodic surveys of each laboratory or other area where radioactive materials are used or stored. Surveys shall be made using methods and instruments capable of detecting the radioactive material used or stored in the survey area. Accurate records, including floor plans of rooms with survey locations marked, survey results, and action taken to remove contamination shall be maintained by the affected departments.

### *Area Surveys*

Areas routinely using unsealed gamma emitters, and beta and alpha emitters capable of being detected by survey meters, shall be surveyed at least weekly, but more often when any procedure is likely to produce significant contamination. Where removable contamination is likely, area surveys should complement wipe tests by locating areas suitable for wipe testing. It is suggested that areas with sealed gamma or neutron sources be surveyed monthly, but may be surveyed less often if items are in storage and no changes are made in shielding, location, or other parameters which would affect exposure of personnel.

### *Removable Contamination Surveys*

Wipe tests shall be executed at least weekly in areas where non-sealed sources are routinely used, and more often when special procedures are used. Several locations subject to contamination should be wiped with filter paper or other suitable material over an area of approximately 100 square centimeters and the swipe counted appropriately (tritium and other very weak emitters will require the use of a scintillation counter). Counting results should be referenced to locations on the floor plan.

While removal of any surface contamination is prudent, removable contamination in restricted areas **shall not** exceed the following levels for any 100 square centimeter area:

Radiation Emitted	Maximum Contamination
Alpha	220 dpm
Beta or Gamma	2,200 dpm
Low Energy Beta (less than 0.2 MeV)	22,200 dpm

Removable contamination per 100 square centimeters **shall not** exceed the following levels in unrestricted areas and on skin:

Radiation Emitted	Maximum Contamination
Alpha	22 dpm
Beta or Gamma	220 dpm
Low Energy Beta	2,200 dpm

[Counts per minute must be corrected for background and counting efficiency of the instrument to give accurate dpm (disintegrations per minute).]

## **Sealed Source Leak Tests**

Sealed radioactive sources must be leak tested at least every six months. Removable contamination on any source in excess of 0.005 microcurie ( $\mu\text{Ci}$ ) shall cause the source to be immediately withdrawn from use, decontaminated, and repaired or disposed of. Copies of leak test results shall be maintained by the RSO who will file all necessary reports with regulatory authorities.

## **Survey Instrument Calibration**

Survey instruments assigned to departments shall be calibrated at least annually and immediately following any maintenance (including replacement of batteries). The RSO shall perform the calibrations, or provide for calibration services through a vendor. It is the responsibility of the RU or department chair to assure that instruments in need of maintenance or calibration are turned over to the RSO in a timely manner.

## **Signs and Labels**

### *Radiation Producing Devices*

All x-ray machines and related devices capable of generating ionizing radiation shall have affixed to the control panel near the power switch a readily visible label stating:

**CAUTION (or DANGER) - RADIATION**

**THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED**

Analytical x-ray machines shall also have a warning label affixed on or near the tube head stating:

**CAUTION (or DANGER) - HIGH INTENSITY X-RAY BEAM**

### *Radiation Area*

Each room or area accessible to personnel in which there exists radiation levels such that a major portion of the body could receive a dose in excess of 5 millirems in 1 hour, or 100 millirems in any 5 consecutive days, shall be conspicuously posted with a sign or signs displaying the radiation symbol and the words:

**CAUTION (or DANGER) - RADIATION AREA**

### *High Radiation Area*

Each room or area accessible to personnel in which there exists radiation levels such that a major portion of the body could receive a dose in excess of 100 millirems in any one hour, shall be conspicuously posted with a sign or signs displaying the radiation symbol and the words:

**CAUTION (or DANGER) - HIGH RADIATION AREA**

### *Airborne Radioactivity Area*

Any room, enclosure, or area in which airborne radioactive materials exist in concentrations in excess of amounts noted in Schedule RHS 8-30, Table 1, Column 3, or any such area in which concentrations could cause an intake of 0.6 percent of that noted in RHS 8-30, Table 1, Columns 2 or 3, in any one week by unprotected personnel, shall be conspicuously posted with a sign or signs displaying the radiation symbol and the words:

**CAUTION (or DANGER) - AIRBORNE RADIOACTIVITY AREA**

### *Other Areas*

Each area or room where radioactive materials are used or stored in amounts exceeding 10 times those noted in Schedule RHS 8-31 shall be conspicuously posted with a sign or signs displaying the radiation symbol and the words:

**CAUTION (or DANGER) - RADIOACTIVE MATERIAL**

### *Containers*

Each container of licensed material shall bear a durable, clearly visible label identifying the contents, displaying the radiation symbol, and the words:

**CAUTION (or DANGER) - RADIOACTIVE MATERIAL**

No such label shall be required for containers holding licensed materials in quantities less than applicable quantities listed in Schedule RHS 8-31, or in concentrations less than those in Schedule RHS 8-30, Table 1, Column 3.

In addition to other posting requirements, copies of "Notice to Employees" (RHS 8-3) shall be posted in sufficient numbers to allow employees to observe a copy on the way to or from an area where radioactive materials or radiation producing devices are used or stored.

## **Security**

All areas housing licensed materials or registered devices shall be secured against unauthorized entry during off duty hours. Radiation areas and high radiation areas shall be secured against unauthorized entry at all times.

## **Radioactive Waste Disposal**

Because of difficulty in disposing of radioactive wastes and the cost involved, researchers shall carefully plan experiments to minimize waste and choose isotopes which can be most easily disposed of. Mixed wastes (radioactive waste combined with hazardous and/or infectious waste) are especially difficult to dispose of; therefore, every effort shall be made to avoid creation of mixed wastes. Departments generating mixed wastes may be held fully responsible for costs associated with management and/or disposal of such wastes.

Radioactive waste shall be collected in appropriate containers which can be sealed against leaks or spills, and stored in a secure, properly marked area until disposal is affected. Containers must be clearly labeled with an inventory of the contents, date accumulation started and ended, and the words "RADIOACTIVE WASTE." It is the responsibility of laboratory personnel to assure that housekeeping personnel are informed of the presence of these containers and that such containers are not to be emptied.

Wastes containing radionuclides with half-lives of less than ninety (90) days should be held for at least ten (10) half-lives (decaying to background levels as confirmed by surveys), then disposed of as normal solid waste after obliterating radioactive markings. However, wastes which are contaminated with hazardous chemicals or infectious agents must be disposed of as hazardous or infectious waste after decaying to background levels. Records reflecting decay time, survey methods and results, and final disposition of waste material are a necessity; the form included in the appendix may be used for this purpose.

Certain aqueous scintillation fluids may be disposed of via sanitary sewer so long as all the following conditions are met:

- Vials contain H-3 or C-14 in concentrations not greater than 0.05  $\mu\text{Ci/g}$  of solution,
- Limits set in 1200-2-5-.122 are not exceeded,
- There are no hazardous chemicals or infectious agents associated with the contents, and
- Volumes dumped are relatively small and acceptable under the Memphis Sewer Use Ordinance.

Aqueous solutions containing other isotopes which have decayed to background levels or are of acceptably low activity may also be released into the sanitary sewer provided they contain no other hazardous constituents. Proper records must be maintained on disposal via sanitary sewer. Empty vials may be placed in normal solid waste after decontamination.

Non-aqueous solutions meeting the above criteria must be held for disposal as hazardous waste.

Scintillation vials of materials having similar waste components and characteristics should typically be emptied into a common container of no more than one (1) gallon in size, properly labeled, and held for disposal. The empty vials may be decontaminated and disposed of in the building solid waste. Where triple rinsing does not properly decontaminate vials, they must be held for disposal by one of the University waste contractors. Call Environmental Health and Safety at 678-4672 for guidance prior to beginning such operations.

All items not meeting the above criteria must be held for disposal as radioactive, hazardous, or infectious waste. Notify Environmental Health and Safety to schedule proper disposal.

## **Decommissioning**

Prior to the closing of a laboratory or other area where radioisotopes have been used or stored, departments shall develop procedures for the decommissioning of such areas. These procedures shall provide for: decontamination to levels suitable for unrestricted areas, or provisions for continued monitoring and security of a restricted area; surveys documenting contamination levels; transferring records of receipt and disposal, periodic surveys, etc. to a responsible person within the department to assure continued integrity of documentation; disposal of all radioisotopes, or their transfer to another Responsible User; and timely notification of closing to the Radiation Safety Office. It shall be the responsibility of the department chair or director to assure that the decommissioning process is fully implemented.

Where personnel leave the University or transfer to another lab, the department chair or director shall assure that all radioactive materials under supervision of such personnel are disposed of, transferred to another lab, or removed to storage.

### **Summary of User Responsibilities**

Every user of radioactive materials or radiation producing devices is responsible for:

- Familiarity with the contents of this manual;
- Maintaining exposure to themselves and others as low as reasonably achievable;
- Wearing and using assigned dosimeters appropriately;
- Performing and documenting frequent laboratory radiation surveys;
- Maintaining records of receipt and disposal of radioisotopes;
- Using only those isotopes specifically authorized and in authorized areas;
- Transferring radioactive materials only as described in this manual;
- Disposing of radioactive waste in accordance with regulations and this manual;
- Storing radioactive materials in secure locations which will result in minimal exposure to personnel;
- Assuring that radioactive materials are never stored in refrigerators or other areas where food for human consumption is stored;
- Maintaining a work area which is clean and orderly;
- Avoiding horseplay and other behavior which could distract personnel;
- Abstaining from smoking, eating, drinking, taking medications, and applying cosmetics in areas where unsealed radioisotopes are used or stored; and
- Following safe work practices as outlined in this manual, the Chemical Hygiene Plan, and other sources.

## **On-line Appendices**

Equipment Release Form

Laboratory Decommissioning Form

Laboratory Specific Standard Operating Procedure Form

Personal Protective Equipment Guidelines

Radiation Safety Checklist

Radiation Wipe Test/Area Monitoring Record

Radioisotope Protocol Preparation Guide

Workplace Hazard Assessment Guide for Personal Protective Equipment