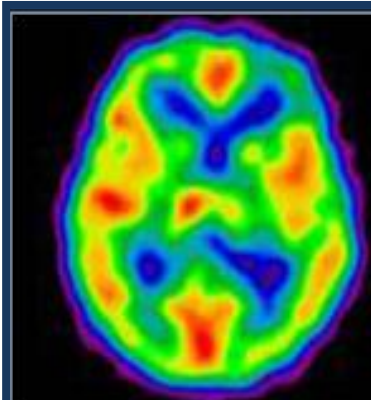




# Radiation Safety Manual: Medical Applications



The purpose of this manual is to provide clinicians, medical physicists and technologists who administer radioactive material to patients with policy and procedure regarding the safe use and disposal of radioactive material as approved for human use by the University Radiation Safety Committee under the University's Broad Medical License.

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Revised 2015

## CONTACT INFORMATION

### IN CASE OF A RADIATION EMERGENCY DURING NORMAL WORKING HOURS:

(Monday through Friday 8:15 am – 4:45 pm)

Call the RSO at

(304) 293 – 3413

### IN CASE OF A RADIATION EMERGENCY OUTSIDE NORMAL WORKING HOURS:

Page the on call Radiation Safety Specialist at

(304) 987 – 1586

When asked “number to be displayed,” enter your **full** 7-digit telephone number.

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# 1. INTRODUCTION

## 1.1 RADIOACTIVITY AND RADIATION

All matter in our environment is made of atoms. Most atoms we encounter on Earth are stable. Some atoms, however, are unstable, giving off energy in the form of radiation in order to reach a stable state. These atoms are said to be radioactive. An example is the radionuclide, Carbon-14, produced in the atmosphere when cosmic rays interact with stable nitrogen atoms. When a Carbon-14 atom undergoes radioactive decay, it gives off radiation in the form of a beta particle and then becomes a stable nitrogen atom once again. The existence of Carbon-14 in all living things enables archaeologists to date ancient artifacts.

Radiation can be naturally-occurring or produced electrically, as in an x-ray tube. Radiation can only be detected by specially designed instruments. Radiation may pass through an object, but it may be absorbed and cause changes at the site of absorption. Radiation is known to cause cancer and birth defects in animals and humans. The risk of radiation damage is related to the amount of radiation absorbed by an individual.

There are small amounts of naturally-occurring radioactive substances in soil, rocks, plants, animals, and in our own bodies, all of which give off radiation. Large amounts of radiation are present in outer space and a small portion of this radiation penetrates the atmosphere. This low level of naturally occurring radiation is known as background radiation.

Radiation is useful because of its ability to penetrate tissue, allowing imaging of internal structures. However radiation may produce harmful biological effects. Observations of exposed human populations and animal experimentation indicate that exposure to low levels of radiation over a period of years may lead to an increase in the incidence of cancer and leukemia. Exposures to high levels of radiation produce the same effects faster and may also cause hair loss, skin burns, radiation sickness or even death. Radiation may also increase the risk of genetic abnormalities.

## 1.2 PURPOSE OF THE RADIATION SAFETY MANUAL

The purpose of this manual is to provide clinicians, medical physicists and technologists who administer radioactive material to patients with policies and procedures regarding the safe use and disposal of radioactive material as approved for human use by the University Radiation Safety Committee under West Virginia University Hospitals' Broad Scope Medical License.

The Administration of West Virginia University has a commitment to providing a safe environment for faculty, staff and patients during the medical use of radioactive material. It is the responsibility of all Deans, Department Chairs and clinicians to implement radiation safety policy and procedure as approved by the University Radiation Safety Committee under the authority delegated by the Administration. Oversight of these policies and procedures is carried



out by the Radiation Safety Department under the supervision of the Radiation Safety Officer (RSO).

The policies and procedures provided in this manual use the terms *shall* and *should*. The use of these terms are consistent with Nuclear Regulatory Commission, State of West Virginia Code of Regulations (Title 64 CFR 23) and National Council of Radiation Protection and Measurements (NCRP).

### **1.3 RADIATION PROTECTION – ALARA**

To minimize the biological effects of radiation, special rules and regulations are set forth for individuals occupationally exposed to radiation. There is, in general, minimal external radiation hazard to personnel from procedures involving radiation. Adherence to guidelines contained in this manual will help employees and students keep their exposures as low as reasonable achievable (ALARA), and should reduce radiation exposures to levels allowable for individuals or in some cases, to levels indistinguishable from natural background.

The radiation protection program is guided by the concept of keeping radiation exposure ALARA. The ALARA concept is based on the assumption that any radiation dose, no matter how small, can have some adverse effect. Under the ALARA program, every reasonable means of lowering exposure is used.

Radiation exposure can be minimized by utilizing three basic principles:

- 1. Time:** Shorter exposure time means a lower dose.
- 2. Distance:** Doubling the distance from a radiation source means one-fourth the dose rate.
- 3. Shielding:** The use of appropriate shielding greatly reduces the dose rate. Standing in a protected area during x-ray exposures is one example.

Remember that radiation cannot be seen or felt, but can be detected with radiation survey meters.

## **2. AUTHORITY & RESPONSIBILITY**

### **2.1 RADIATION SAFETY COMMITTEE**

The Radiation Safety Committee is composed of the Provost of West Virginia University or his/her representative, the Vice President for Health Sciences or his/her representative, the Dean of the College of Medicine or his/her representative, the President of West Virginia University Hospitals, Inc. or his/her representative, others who may be nominated by any of the above, the RSO and the chairperson of each of the Radiation Safety Committees reporting to the Radiation Safety Committee.

The committee meets at least quarterly to:

- A. Adopt rules and policies on the use of ionizing radiation within the university and the hospital.
- B. Review plans for all new buildings and modifications of existing structures where ionizing radiation is to be used.
- C. Review reports by the RSO and the chairs of the Radiation Safety Committees.
- D. Approve or modify proposals for amendments to the various licenses or applications for new licenses.

Perform an annual review of the content and implementation of the Radiation Safety Program including ALARA considerations. This includes a review of the operation of the Radiation Safety Department on at least an annual basis to ensure that all license obligations and regulations of the U.S. Nuclear Regulatory Commission and the West Virginia Department of Health are met and that sources of ionizing radiation are being used in a safe manner.

Approve changes in the Radiation Safety Manual and recommend changes when these become necessary.

### **2.2 HUMAN USE OF RADIATION AND RADIONUCLIDES COMMITTEE**

The committee is composed of the chair of the Radiology Department or his/her representative, the Director of Nursing Service or his/her representative, physicians who are experts in radiation therapy, nuclear medicine, internal medicine, hematology or cardiology, a person experienced in the assay of radionuclides, and the RSO, as well as such additional members as shall be nominated by the chair of the Radiation Safety Committee and the RSO in consultation with the committee. This committee functions as the Radiation Safety Committee of the hospital so far as the diagnostic or therapeutic use of radiation on humans is concerned.

The committee meets at least quarterly to:

- A. Adopt rules and policies pertaining to the use of ionizing radiation in or on humans at WVU Hospitals or the Robert C. Byrd Health Sciences Center.
- B. Review and either approve or return for amendment all proposals for the use of radiation or radionuclides in or on humans.
- C. Evaluate the qualifications of all persons proposing to use radiation or radionuclides in or on humans to ensure that they are adequate for the proposed use.
- D. Review plans for all new buildings and modifications of existing buildings where ionizing radiation is to be used in or on humans and to send its recommendations to the Radiation Safety Committee.
- E. Review proposed shielding and operations of all radiation producing machines and equipment used for the exposure of humans.
- F. Review all instances of alleged infractions of rules and unsafe practices in the human use of ionizing radiation, and take the steps necessary to ensure safe practice. This may entail recommendations to the Radiation Safety Committee or to appropriate supervisory personnel in the department in which an offense occurs.
- G. Review reports from the Radiation Safety Department on the use of ionizing radiation in or on humans, including any changes or impending changes in regulations.
- H. Ensure that all license obligations and federal and state regulations are met and that safe practice is maintained in the human use of ionizing radiation.

### **2.3 NON-HUMAN USE OF RADIATION AND RADIONUCLIDES COMMITTEE**

The committee is composed of faculty members experienced in the laboratory use of radionuclides, the chairs of the Committee on the Use of Radiation and Radionuclides in Animals and the Radiation Research Committee or their representative, the RSO, and others who may be nominated by the chair of the Radiation Safety Committee and the RSO. The committee meets at least quarterly to:

- A. Adopt rules and policies on the in vitro use of sources of ionizing radiation at WVU Hospitals, West Virginia University, the Robert C. Byrd Health Sciences Center, the Blanchette Rockefeller Neurosciences Institute, and at the Charleston Division.

- B. Review and either approve or return for amendment all proposals for the in vitro use of ionizing radiation.
- C. Evaluate the qualifications of all persons proposing the in vitro use of radiation to ensure that they are adequate for the proposed use.
- D. Review plans for all new buildings and modifications of existing buildings where ionizing radiation is to be used in vitro and send its recommendations to the Radiation Safety Committee.
- E. Review all instances of alleged infractions of rules and unsafe practices in the use of ionizing radiation in vitro and take the steps necessary to ensure safe practice. This may entail recommendations to the Radiation Safety Committee or to appropriate supervisory personnel in the department in which an offense occurs.
- F. Review reports from the Radiation Safety Department on the use of ionizing radiation in vitro including any changes or impending changes in regulations.
- G. Ensure that all license obligations and federal and state regulations are met and that safe practice is maintained in the in vitro use of ionizing radiation.
- H. Activate the subcommittees on Animal Use or Radiation Research necessary to review activities within their jurisdiction.

#### **2.4 COMMITTEE ON THE USE OF RADIATION AND RADIONUCLIDES IN ANIMALS**

The committee is composed of the director of the animal quarters, a person experienced in the assay of radionuclides, the RSO and others who may be nominated by the chair of the Radiation Safety Committee and the RSO. The committee functions as a subcommittee of the Nonhuman Use of Radiation and Radionuclides Committee.

The committee will meet when necessary to:

- A. Adopt rules and policies for the use of ionizing radiation in or on animals.
- B. Review and either approve or return for amendment all proposals for the use of ionizing radiation in or on animals.
- C. Evaluate the qualifications of all persons proposing to use radiation or radionuclides in or on animals to ensure that they are adequate for the proposed use.

- D. Review plans for all new buildings and modifications of existing buildings where ionizing radiation is to be used in or on animals and send its recommendations to the Radiation Safety Committee.
- E. Review all instances of alleged infractions of rules and unsafe practices in the use of ionizing radiation in or on animals and take the necessary steps to ensure safe practice. This may entail recommendations to the Radiation Safety Committee or to appropriate supervisory personnel in the department in which an offense occurs.
- F. Review reports from the Radiation Safety Department on the use of ionizing radiation in or on animals including any changes or impending changes in regulations.
- G. Ensure that all license obligations and federal and state regulations are met and that safe practice is maintained in the use of ionizing radiation in or on animals.

## **2.5 RADIATION RESEARCH COMMITTEE**

The committee is composed of scientists and engineers of the Downtown and Evansdale campuses of WVU who have experience in the use of radionuclides in research protocols, the RSO and others who may be nominated by the chairman of the Radiation Safety Committee and the RSO. The committee functions as a subcommittee of the Nonhuman Use of Radiation and Radionuclides Committee.

The committee will meet when necessary to:

- A. Adopt rules and policies on the use of ionizing radiation on the Downtown and Evansdale campuses.
- B. Review and either approve or return for amendment all proposals for the use of radiation or radionuclides on the Downtown or Evansdale campus.
- C. Evaluate the qualifications of all persons proposing to use radionuclides on the Downtown or Evansdale campus to ensure that they are adequate for the proposed use.
- D. Review plans for all new buildings and modifications of existing buildings where ionizing radiation is to be used on the Downtown or Evansdale campus and send its recommendations to the Radiation Safety Committee.
- E. Review all instances of alleged infractions of rules and unsafe practices in using ionizing radiation on either the Downtown or Evansdale campus and take the necessary steps to ensure safe practice. This may entail recommendations to the Radiation Safety

Committee or to supervisory personnel in the department in which an offense occurs.

- F. Review reports from the Radiation Safety Department on the use of ionizing radiation on either the Downtown or the Evansdale campus including any changes or impending changes in regulations that might affect these campuses.
- G. Ensure that all license obligations and federal and state regulations are met and that safe practice is maintained in the use of ionizing radiation on the Downtown and Evansdale campuses.

## **2.6 RADIATION SAFETY OFFICER/ RADIATION SAFETY DEPARTMENT**

The responsibilities of the RSO/Radiation Safety Department include the following:

- A. To furnish consulting services to any potential user of ionizing radiation and to advise the potential user on radiation safety procedures.
- B. To ensure that all license obligations and regulations of the federal and state government are met.
- C. To provide general surveillance of all health physics activities, including assisting all personnel in discharging their responsibilities.
- D. To supervise the procurement and receipt of all radioactive materials coming to the university and the hospital.
- E. To provide for individual and laboratory monitoring.
- F. To instruct university and hospital personnel in radiation safety.
- G. To administer a radioactive waste disposal program.
- H. To perform leak tests on sealed sources and provide radiation surveys after installation of radiation producing machines.
- I. To supervise decontamination in case of accidents.
- J. To provide a continuous program of environmental radiation hazard evaluation and hazard elimination.

- K. To provide advice and assistance in the acquisition of dosimeters and monitoring equipment.
- L. To provide maintenance and calibration of survey instruments in the Radiation Safety Department.
- M. To maintain all centralized records pertinent to the radiation safety program.
- N. To develop and refine radiation detection, shielding and health protection techniques.
- O. To be responsible for the overall day-to-day administration of the radiation safety program.
- P. To suspend any operation causing excessive radiation hazard as rapidly and safely as possible. (In carrying out this duty the RSO will report directly to the Vice President of WVU Health Sciences and the Provost of the University).
- Q. To present periodic reports to the various committees on matters related to their functions.
- R. To keep each department chair informed of all Authorized Users in the department who are conducting projects approved by a radiation safety committee.
- S. To provide timely reports to the U.S. Nuclear Regulatory Commission and the West Virginia Department of Health as required by regulation.
- T. To maintain an inventory and accountability record of the radioactive material used at the university and the hospital to ensure compliance with license limits.

## **2.7 DEPARTMENT CHAIRS**

The Department Chairs' responsibilities include the following:

- A. To have plans for all new buildings and modifications of existing structures, where ionizing radiation is to be used, submitted through the Radiation Safety Department for approval by the appropriate Radiation Safety Committee prior to the construction or modification.
- B. To have any area where radionuclides were previously used surveyed by the Radiation Safety Department before workmen do any rearranging of the area. Call the Radiation Safety Department (304-293-3413) to ensure that any needed decontamination or disposal is carried out properly.

- C. To have new staff members who desire to use ionizing radiation secure a copy of this Radiation Safety Manual from the Radiation Safety Department. In particular, the new staff member's attention should initially be directed to Section 4, "Procurement of Radioactive Materials" for information about transferring radionuclides and equipment containing radionuclides to the university or hospital from another institution.
- D. To have Authorized Users who are leaving the university or changing laboratories inform the Radiation Safety Department. They should arrange for the transfer of unused radionuclides to other Authorized Users and have any radioactive waste picked up by Radiation Safety. This will keep any potentially hazardous material from being unsupervised when a faculty member terminates.

*Note: The RSO will keep each Department Chair informed of all Authorized Users in the department who are conducting projects approved by any of the radiation safety committees.*

## **2.8 AUTHORIZED USERS**

The Authorized User shall be responsible for:

- A. Controlling employee and visitor exposures, keeping them ALARA and always below the dose limits in Section 6.2, "Requirement to Keep Doses ALARA."
- B. Requesting proper radiation monitoring devices for laboratory personnel.
- C. Providing suitable monitoring instruments, protective clothing, equipment (such as shielding, if required) and supplies for employees.
- D. Notifying the Radiation Safety Department of any change or proposed change in radionuclide use which might affect radiation protection procedures.
- E. Following correct procedures for procurement of radionuclides and radiation producing devices.
- F. Maintaining up-to-date marking and labeling of laboratories, radioactive materials and equipment.
- G. Properly disposing of radioactive wastes and producing accurate disposal records.
- H. Immediately reporting to the Radiation Safety Department any spills, suspected overexposures, theft or misuse of radioactive material, and other accidents or incidents involving radiation or radioactive materials.



- I. Safely operating any radiation producing device for which s/he is listed as the possessor.
- J. Testing and care of radiation sources made by university or hospital personnel.
- K. Properly administering and using sources of radiation in or on humans (if authorized for this type of use).
- L. Providing employees with copies of portions of the Radiation Safety Manual applicable to them, such as:
  - 1. General Procedures for Physicians (Section 9.1)
  - 2. General Procedures for Nurses (Section 9.2)
  - 3. General Procedures for Radiation Producing Equipment Operators (Section 9.3)
  - 4. Emergency Procedures and Decontamination Procedures (Sections 12 and 13)
- M. Attending periodic in-service training sessions presented by the Radiation Safety Department and requiring that students and employees attend the orientation and in-service training sessions appropriate for them.
- N. Properly using radiation sources in or on animals (if applicable).
- O. Properly using a sealed source irradiator facility (if applicable).
- P. Securely storing all radiation sources used under his or her direction.
- Q. Making sure that appropriate surveys and monitoring are performed, any needed corrective action is carried out and that necessary records are maintained.
- R. Properly transferring radioactive material while working at the university or hospital and prior to leaving (as applicable).
- S. Ensuring that radiation survey instruments are calibrated periodically for the type of radiation to be measured.

*Note: The Authorized User is fully responsible for adherence to these requirements and the safe use of ionizing radiation by him/herself and those under his/her direction.*

## **2.9 INDIVIDUAL RADIATION WORKERS**

An individual shall be responsible for:

- A. Controlling his/her radiation exposure, keeping it as low as is reasonably achievable and always below the dose limits in Section 6.
- B. Assisting the Authorized User in keeping the marking and labeling of laboratories, radioactive materials and equipment up-to-date.
- C. Maintaining good housekeeping, minimizing clutter, and reducing the chance of transfer of contamination.
- D. Carrying out monitoring of self, work area and lab, and producing required records of the monitoring performed.
- E. Using appropriate instruments, checking for proper operation before use and reporting any problems to the Authorized User in a timely manner.
- F. Storing and securing radioactive material properly.
- G. Wearing appropriate protective clothing such as a lab coat and gloves.
- H. Wearing and storing personal radiation monitors properly.
- I. Disposing of radioactive wastes appropriately and keeping accurate disposal records.
- J. Properly testing and caring for radiation sources made by university or hospital personnel.
- K. Promptly reporting spills, suspected overexposures, theft of material and other incidents to the Radiation Safety Department.
- L. Maintaining a working knowledge of emergency and decontamination procedures.
- M. Becoming familiar with his or her specific area of concern.

### 3. CRITERIA FOR EVALUATING USER QUALIFICATIONS FOR THE USE OF RADIOACTIVE MATERIALS

#### 3.1 HUMAN USE OF RADIOPHARMACEUTICAL DRUG PRODUCTS APPROVED FOR ROUTINE PROCEDURES

In order to use radioactive material for human use not exempted by the State of West Virginia, an individual must first be approved as an Authorized User by the appropriate radiation safety committee. The RSO may grant temporary approval pending review by the committee. A prospective Authorized User must submit an application for the use of radiopharmaceuticals to the Radiation Safety Department (see Contact Information). An applicant must show that they fulfill the pertinent training and experience requirements in 10 CFR 35 Subpart B. These include board certification or specific training in relevant radioisotope handling techniques and appropriate clinical experience. Applicants should support their training and experience history with a preceptor statement from their training institution.

#### 3.2 HUMAN USE OF RADIONUCLIDES IN NON-ROUTINE OR EXPERIMENTAL PROCEDURES

The use of all experimental techniques on humans involving radioactive material or otherwise is governed by the WVU Institutional Review Board (IRB). All experimental procedures involving radiation exposure must also be approved by the Human Use of Radiation and Radionuclides committee. Protocols which involve procedures which are in clinical practice or have been approved by the Human Use committee may be approved by the RSO. The Human Use committee has adopted the radiation exposure limits for all research subjects which are required for FDA studies per 21 CFR 361.1(b)(3)(i & ii). These limits are given in Table 1, Radiation Dose Limits for Research Subjects. Research protocols should be submitted to the RSO as early as possible to permit an adequate review and estimation of patient exposure.

TABLE 1: RADIATION DOSE LIMITS FOR RESEARCH SUBJECTS

		Whole Body (EDE <sup>a</sup> )	Organ Maximum
Adult	Per Study	3,000 mrem	5,000 mrem
	Annual	5,000 mrem	15,000 mrem
Under Age 18	Per Study	300 mrem	500 mrem
	Annual	500 mrem	1,500 mrem

a. EDE: Effective Dose Equivalent

Similarly, all research protocols which involve the use of radiation or radionuclides in animals must be approved by the Animal Care and Use Committee, a branch of the IRB. Contact the Institutional Review Board at (304) 293-7073 or P.O. Box 6845 for further information.

## **4. PROCUREMENT OF RADIOACTIVE MATERIALS**

### **4.1 ORDERING OF ROUTINELY USED MATERIAL**

The immediate approval of a purchase order for radioactive material is delegated by the Nuclear Medicine Physician to the Nuclear Medicine Technologist. The Nuclear Medicine Physician must be authorized by the University Radiation Safety Committee to use radiopharmaceuticals for human use and such uses must be reviewed by the RSO. The Nuclear Medicine Technologist is responsible for the inventory of all radioactive material used routinely. Radioactive materials will be procured from NRC or State licensed suppliers.

### **4.2 QUALITY MANAGEMENT**

- A. A written directive will be obtained from the physician who will perform or oversee the procedure. The written directive will contain the isotope, total prescribed dose and signature and date of the authorized user.
- B. Persons ordering the material will reference the physician's written request when placing the order. The physician's request will indicate isotope, compound, activity level, patient's name, etc.
- C. The physician's written request will be referenced when receiving, opening, or storing the radioactive material.
- D. It is essential that written records be maintained for all ordering and receipt procedures.
- E. Appendix 1 will serve as a model for ordering and receiving radioactive material.

### **4.3 RECEIPTS, TRANSFERS, UNPACKING AND STORAGE**

Radioactive materials are normally delivered to the Nuclear Medicine Hot Laboratory during working hours. During off duty hours, the packages are received as per Appendix 1.

All personnel involved with the receipt of radioactive material shipments must be instructed in the proper procedures and precautions. Appendix 1 is a model for written instructions for this purpose. A copy of these instructions is to be given to all involved individuals.

Unpacking of radioactive material receipts must be done in accordance with the established safety procedures described on Appendix 1.

#### 4.4 RECORDS

Each clinical area is responsible for maintaining the master record file or log of all radioactive material ordered, received, transferred, used and disposed. The Nuclear Medicine Technologist, Medical Physicist, or Dosimetrist will maintain these records under the supervision of the RSO. Records of radiation surveys, incident reports, personnel dosimetry results, leak tests, and survey instrument calibration shall also be maintained in each clinical area.

- A. The following records must be kept and are to be available for inspection at *any time* by the Radiation Safety Department and authorized regulatory agency representatives:
  - 1. Type and amount of radionuclides on hand.
  - 2. Results of radiation surveys.
  - 3. Sealed source leak tests and inventories, dose calibrator quality control testing, and survey meter calibrations control testing, and survey meter calibrations.
  - 4. Method and amount of disposal, including radiation survey results for material held for decay.
  - 5. Patient dose records, including patient's name dose prescribed, dose assayed, type of procedure, and date. Records will be retained for review by the licensing body for the periods specified below.
  
- B. The following records must be kept indefinitely:
  - 1. Personnel Monitoring and Bioassay Records
  - 2. Radiation Accident Investigation Results
  - 3. Radiation Safety Committee Minutes
  
- C. The following records must be kept for ten (10) years:
  - 1. Medical Event Reports
  
- D. The following records must be kept for five (5) years:
  - 1. Sealed Source Leak Test and Inventory Results
  
- E. The following records must be kept for three (3) years:
  - 1. Patient Dose Records
  - 2. Survey Results, Including Area Surveys and Hold For Decay Surveys
  - 3. Mo-99 Breakthrough Results
  - 4. Survey Meter Calibration and Dose Calibrator QC Test Results

## **5. STORAGE OF RADIONUCLIDES**

### **5.1 LIQUIDS AND SOLIDS**

All sources of radiation shall be secured against unauthorized removal from the places of storage or use and shall be provided with reasonable protection against loss, leakage, or dispersion by the effects of fire or water. Radioactive material in a controlled or unrestricted area that is not in storage shall be controlled and given constant surveillance.

It is important that all stored radioactive samples be clearly labeled at all times. The label should show the radionuclides, their activity and date of activity, the chemical form, and the name of the responsible Authorized User plus any additional information that would help an individual to minimize his or her exposure.

Storage sites for large amounts of radioactive materials should be as remote from occupied areas as practicable. Materials must be stored so that the dose in any unrestricted area from external sources does not exceed 0.02 mSv (2 mrems) in any one hour. The total effective dose equivalent to individual members of the public shall not exceed 1 mSv (100 mrems) in a year.

Storage areas must be well-marked with appropriate signs. These should read “Caution-Radioactive Materials” or “Caution-Radiation Area.” The name, address, and phone number of the responsible person and the RSO shall be posted in a conspicuous place near the area. See Appendix 2 for examples of approved signs and labels.

### **5.2 GASES**

The storage requirements listed above apply as well to radioactive gases. In addition, radioactive gas cylinders or ampoules and radioactive solutions that emit gases should be labeled and kept in approved hoods which are provided with appropriate filters. Only the amounts of material necessary for immediate use should be stored.

## **6. RADIATION PROTECTION MEASURES**

### **6.1 INTRODUCTION**

There are two general ways in which the body may be irradiated:

- A. Radionuclides outside the body (external sources of gamma and/or high energy beta emitters)
  
- B. Radionuclides inside the body (internal exposures from any radionuclide)
  - 1. Breathing radioactive vapor
  - 2. Ingesting radioactive material food, water, or from contaminated hands
  - 3. Entering through a cut
  - 4. Absorption through the skin

Exposure limits have been set for the protection of both personnel and the general public. It must be emphasized that the following limits are maximum permissible limits. In general, exposure is to be kept ALARA.

The radiation protection limits specified in this section are set so that an individual could be allowed to receive doses up to the limits each year for all of his/her working life. Most radiation protection guidelines are based on the assumption that any dose of ionizing radiation, no matter how small, may produce some genetic or somatic damage, and thus it is considered wise to avoid all unnecessary exposure to radiation.

### **6.2 REQUIREMENT TO KEEP DOSES ALARA**

All licensees and permit holders are required by the Nuclear Regulatory Commission (NRC) and the West Virginia Department of Health (WVDOH) to use, to the extent practicable, procedures and engineering controls that are based upon sound radiation protection principles so that occupational doses and doses to members of the public are ALARA.

This means that operations must be planned, monitored, and carried out so that any dose received is not only below the limits established in this manual, but also is as far below the limits as is reasonable to achieve. Adequate preparation must be made so that appropriate engineering provisions can be installed.

### **6.3 RADIATION PROTECTION LIMITS**

West Virginia University Hospitals, Inc. must comply with the radiation protection limits specified by the NRC in 10 CFR 20 and by the WVDOH in 64 CSR 23. These dose limits apply to radiation exposures above those received from background radiation and medical exposure.

The regulations require that doses from external and internal sources must be monitored if an individual is likely to receive a dose in excess of 10% of the applicable dose limits. If both external and internal doses must be monitored, the dose resulting from each must be added together and the sum compared to the appropriate annual limit.

Limits are issued for occupationally exposed individuals: adults, minors, and an embryo/fetus. Dose limits for individual members of the public are also included.

### **6.3.1 NRC OCCUPATIONAL DOSE LIMITS**

For adults, an annual limit shall not exceed:

- A. 5 rems (0.05 Sv) for the total effective dose equivalent (TEDE), which is the sum of the deep dose equivalent (DDE) from external exposure to the whole body and the committed effective dose equivalent (CEDE) from intakes of radioactive material.
- B. 50 rems (0.5 Sv) for the total organ dose equivalent (TODE), which is the sum of the DDE from external exposure to the whole body and the committed dose equivalent (CDE) from intakes of radioactive material to any individual organ or tissue, other than the lens of the eye.
- C. 15 rems (0.15 Sv) for the lens dose equivalent (LDE), which is the external dose to the lens of the eye.
- D. 50 rems (0.5 Sv) for the shallow dose equivalent (SDE), which is the external dose to the skin or to any extremity.

For minor workers, the annual occupational dose limits are ten percent (10%) of the dose limits for adult workers.

For protection of the embryo/fetus of a declared pregnant woman, the dose limit is 0.5 rem (5 mSv) during the entire pregnancy. Efforts must be made to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the aforementioned limit. Thus the monthly exposure during pregnancy should be less than 50 mrems (0.5 mSv).

For individual members of the public, the total effective dose equivalent to individual members of the public from licensed operations at the University or Hospital shall not exceed 100 mrems (1 mSv) in a year, exclusive of any dose contribution from the Authorized User's disposal of radioactive material into sanitary sewage, and the dose in any unrestricted area from external sources shall not exceed 2 mrems (0.02 mSv) in any one hour.

## **6.4 INDIVIDUAL MONITORING**

### **6.4.1 CONDITIONS REQUIRING MONITORING**



- A. Each Authorized User must monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of this section. As a minimum each Authorized User must monitor occupational exposure to radiation and must supply/require the use of individual monitoring devices by:
  - A. Adults likely to receive a dose in excess of ten percent (10%) of the limits specified above in one (1) year from sources external to the body.
  - B. Minors and declared pregnant women likely to receive a dose in excess of ten percent (10%) of the applicable limits in one (1) year from sources external to the body, and
  - C. Individuals entering a high or very high radiation area.
  
- B. Each Authorized User must monitor the occupational intake of radioactive material by and have the committed effective dose equivalent calculated for:
  - 1. Adults likely to receive an intake in excess of ten percent (10%) of the applicable Annual Limit on Intake<sup>1</sup> (ALI) in one (1) year, and
  - 2. Minors and declared pregnant women likely to receive a committed effective dose equivalent in excess of 50 mrem (0.5 mSv) in one (1) year.

Contact the Radiation Safety Department for advice and help if you believe that monitoring will be required for internal exposures.

#### **6.4.2 TYPES AND USE OF MONITORING DEVICES**

There are two main options for external, personal monitoring available through the Radiation Safety Department:

- A. **Genesis Thermoluminescent Dosimeter(TLD) Badge:** provides x-ray, gamma, and beta neutron radiation monitoring with optically stimulated luminescence (OSL) technology, utilizing an aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) detector material. The dosimetry badge is affixed to a holder with a clip so that it can be fastened to clothing in a consistent location on the worker's body (waist, chest, or collar).
  
- B. **TLD Ring Dosimeter:** provides extremity monitoring of x-ray, gamma, and beta radiation for workers required to manually manipulate or work in close proximity to radioactive materials and radiation producing equipment. It measures radiation exposure through TLD of a lithium fluoride crystal. The ring is to be worn on the index finger of the worker's dominant hand and is available in sizes small, medium, and large.

It is the responsibility of the Authorized User to request individual monitoring devices for him/herself and for personnel under his/her supervision. To request monitoring devices, call the

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<sup>1</sup> A comprehensive review of such isotopes is available on the NRC web site. (<http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/appb/>)

Radiation Safety Department or visit our website in order to obtain the appropriate forms. The Radiation Safety Department sends personal monitors to a designated representative in each work area for distribution every month or quarter, depending upon the department's exposure monitoring frequency. The representative should collect the old monitors and return them to the Radiation Safety Department promptly, no later than the 10<sup>th</sup> day of the new exposure monitoring cycle. If monitoring devices are not received by that time they will be considered delinquent. Temporary Genesis Thermoluminescent Dosimeter badges and TLD rings may be obtained from the Radiation Safety Department for new personnel or to replace a lost monitoring device.

In order for measured exposures to be truly representative of actual occupational exposures, several precautions should be followed. At the end of the work day, monitoring devices should be left at work in a place where it will not be exposed to radiation. Devices should not be deliberately exposed to radiation other than while being worn. Badges and rings should only be worn by the person to whom they are assigned.

Monthly/Quarterly exposure results will be sent to each Department or area. These results should be posted for the information of those being monitored. Note that there is a delay of about one month from the time a monitoring device is returned to the office before the report is available. An individual who has questions about his/her exposure should contact the Radiation Safety Department. Normally the Radiation Safety Department will contact anyone who receives an unexpectedly high exposure. The reason for the exposure will be determined and, if necessary, changes in procedures to prevent future exposures will be discussed or required.

Present policy is for the Radiation Safety Department to bill each department quarterly for all monitoring charges accrued. These may include charges for individual monitoring devices, badge holders, unreturned ring badges, annual reports, and for vendor's services. These charges are pass-through charges from the vendor.

### **6.4.3 BIOASSAYS**

A bioassay is an after-the-fact check as to whether or not a significant amount of radionuclide entered the body despite what were thought to have been safe procedures. Should such an amount be found, it would signal the need for additional monitoring and a change in procedures so that a work area's tasks can be carried out without undue risk.

The need for a bioassay will depend on the radionuclide used, circumstances under which it is used, the volatility of the substance, and amount of activity involved, in brief, the likelihood of airborne contamination. The following table indicates the quantities and circumstances which warrant attention:

TABLE 2: ACTIVITIES WHICH WARRANT BIOASSAY

Location of Use	Activity Used at One Time or in One Day (mCi)			
	Volatile or Dispersible		Bound to Nonvolatile Agent	
	<sup>3</sup> H	<sup>125</sup> I or <sup>131</sup> I	<sup>3</sup> H	<sup>125</sup> I or <sup>131</sup> I
Open Room or Bench	10	0.1	1	1
Fume Hood	30	1	10	10
Closed Glove Box	30	10	100	10

In order to establish a baseline, a worker should have a routine bioassay, whether it be urinalysis or thyroid scan, before exposure to radionuclides but not over one month prior. Subsequent to exposure, a bioassay should be conducted between six (6) and forty-eight (48) hours after exposure to activity greater than or equal to those listed in Table 2. Should exposure to this activity be frequent, it is sufficient to repeat the test every two (2) weeks. Workers in areas having on hand or having used in a calendar quarter an activity greater than or equal to that listed in the “Closed Glove Box” entry for Table 2 should have a bioassay at least quarterly.

If a thyroid scan is the proposed method of bioassay, call Nuclear Medicine and arrange an appointment. If a scan will be needed over a weekend, call the Radiation Safety Department for assistance.

Analysis of urine samples is the responsibility of the Authorized User. If assistance is needed, call the Radiation Safety Department.

Should a thyroid scan show more than 0.12 µCi of I-125 or more than 0.04 µCi of I-131, notify the Radiation Safety Department immediately so that additional monitoring can begin and corrective actions initiated. Should a urine sample show more than 0.01 µCi/liter of I-125, more than 0.003 µCi/liter of I-131, or more than 5 µCi/liter of H-3, the Radiation Safety Department should be notified. A second sample will normally be tested 24 hours later. If this sample still indicates high activity then additional monitoring and corrective action will be initiated.

## 6.5 USE OF CAUTION SIGNS AND LABELS

The following use of caution signs and labels is required by the NRC and the WVDOH. Although these signs and labels initially will be available from the Radiation Safety Department, Authorized Users should purchase their own if there is a continuing need. Assistance in marking and labeling may be requested by contacting the Radiation Safety Department. Examples of appropriate signs and labels can be found in Appendix 2.

Signs and labels must be current and updated as conditions change. More than one sign may be required. The signs and labels used must describe the actual condition(s) present as defined in the following sections.

### **6.5.1 RADIATION MACHINES**

All radiation machines shall be labeled at the control panel near the energizing switch with:

**“Caution-Radiation: This Equipment Produces Radiation When Energized”**

### **6.5.2 RADIOACTIVE MATERIAL**

The following shall be posted with a **“Caution-Radioactive Material”** sign or label:

- A. Each location of the work area where radioactive materials are USED or STORED in an amount exceeding ten (10) times the quantity of radioactive material specified in 10 CFR 20, Appendix C. A table addressing the most common isotopes at this facility can be found in Appendix 2 of this manual.
- B. Each container in which radioactive material is TRANSPORTED, USED or STORED in amounts greater than the quantity specified in Appendix 2.

Labels on containers must provide sufficient information to permit individuals in the vicinity of the containers to take precautions to avoid or minimize exposures. Such information includes the radionuclides present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, or kinds of materials.

Note: Equipment such as refrigerators or freezers that are used for storage should bear a **"Caution - Radioactive Material"** sign also.

### **6.5.3 RADIATION AREA**

The following area(s) shall be posted with the radiation symbol and a **"Caution - Radiation Area"** sign: any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.05mSv (5 mrems) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

### **6.5.4 HIGH RADIATION AREA**

The following area(s) shall be posted with the radiation symbol and a **"Caution - High Radiation Area"** sign: any area, accessible to individuals, in which radiation levels could result in an excess of 1 mSv (100 mrems) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

### **6.5.5 VERY HIGH RADIATION AREA**

The following area(s) shall be posted with the radiation symbol and a sign bearing the words "**GRAVE DANGER, VERY HIGH RADIATION AREA**": any area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 5 Grays (500 rads) in 1 hour at 1 meter from a radiation source or from any surface that the radiation penetrates.

### **6.5.6 AIRBORNE RADIOACTIVITY AREA**

The following area(s) shall be posted with a "**Caution - Airborne Radioactivity Area**" sign: a room, enclosure or area in which airborne radioactive materials exist in concentrations -

- A. In excess of the derived air concentrations (DACs) specified in 10 CFR 20 Appendix B (<http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/appb/>) or,
- B. To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

## **6.6 CONTROL OF ACCESS TO HIGH RADIATION AREAS**

The Authorized User must ensure that each entrance or access point to a high radiation area has one or more of the following features:

- A. A control device that, upon entry into the area, causes the level of radiation to be reduced below the level at which an individual might receive a deep-dose equivalent of 1 mSv (100 mrem) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates;
- B. A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or
- C. Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

In place of these, continuous electronic surveillance that is capable of preventing unauthorized entry may be substituted. The controls for controlling access must not prevent anyone from leaving the high radiation area.

Control of entrance or access to rooms or other areas in the hospital is not required solely because of the presence of patients containing radioactive material, provided that there are personnel in attendance who will take the necessary precautions to prevent the exposure of individuals to radiation or radioactive material in excess of the limits and to operate within the

ALARA provisions of the radiation safety program.

## **6.7 CONTROL OF ACCESS TO VERY HIGH RADIATION AREAS**

In addition to the requirements in the previous section, the Authorized User must institute additional measures to ensure that an individual is not able to gain access to areas in which radiation levels could be encountered at 5 Grays (500 rads) or more in 1 hour from a radiation source or any surface through which the radiation penetrates.

## 7. RADIATION SAFETY TRAINING

The goal of providing radiation safety training to the employees of West Virginia University Hospitals is to empower workers to take personal responsibility for minimizing their exposure to radiation. By providing each employee with knowledge of radiation and its biological effects and the regulations governing its use, the WVUH can help provide an environment that is safe for its patients, students, visitors and employees. The content of radiation safety training courses will be determined by the RSO and the appropriate Radiation Safety Committee based on applicable regulatory guidance, industry consensus standards, and the specific needs of the target audience. Authorized Users are responsible for ensuring that their staff members have received instruction regarding the safe use of radioactive material and radiation sources in their specific laboratory settings, both through on-the-job training and through formal training offered by the Radiation Safety Department. The Authorized User is responsible for maintaining documentation of the completion of required training and will be required to supply such documentation to the RSO or his/her designee as a condition for continued Authorization to use radioactive material or radiation sources.

### 7.1 INDIVIDUALS OR GROUPS REQUIRING TRAINING

Individuals employed by WVUH fall into three general categories with respect to their exposure to radiation:

- A. **Radiation Workers**: those workers whose major responsibilities involve working with sources of ionizing radiation or radioactive material. This would include radiologists; radiographers; nuclear medicine physicians and technologists; radiopharmacy technologists; radiation therapy technologists; cardiology technologists working with fluoroscopy equipment; research scientists who are Authorized Users of radioactive material or radiation sources; faculty, technicians and graduate students in certain campus laboratories; nurses on hospital divisions regularly caring for radionuclide therapy patients.
- B. **Ancillary Workers**: All personnel who may come in contact with or enter an area that contains radioactive material or sources of ionizing radiation. This would include non-radiology physicians and residents, phlebotomists, Environmental Services workers, waste processors and animal caretakers.
- C. **Non-Radiation Workers**: personnel who would not normally be expected to encounter radioactive material or radiation sources in the course of their employment at WVUH. This would include administrators and administrative assistants, Food Service employees, clerical staff, Materials Management and so forth.

These groups will require different levels and frequencies of training. Authorized Users are required to submit evidence of prior training during the application process for medical or research use of radioactive material and radiation sources. This prior education and training may be applied in lieu of certain initial and update training requirements.

## **7.2 TRAINING FREQUENCY**

Training occurs on an as-needed basis. However, the Radiation Safety Department subscribes to some basic guidelines for the frequency and intensity with which different groups receive their training. These include:

- A. All new employees of WVUH: safety orientation training, including basic information concerning the existence of sources of ionizing radiation and the Radiation Safety program.
- B. Radiation workers: initial training including instruction in the proper use and handling of radioactive material and other sources of ionizing radiation. The content of the initial training may be modified for the specific job responsibilities.
- C. Radiation workers and certain ancillary workers: periodic refresher training.
- D. Re-training of workers whose job responsibilities change concerning their use of or exposure to ionizing radiation, or who request additional radiation safety training.
- E. Special training in connection with incidents involving a procedure of concern, spill, incident, misadministration, change in regulations, or a documented overexposure.
- F. Radiologists, radiographers, nuclear medicine technologists, radiation oncology technologists and radiation dosimetrists, by virtue of their professional education, certification, and continuing education requirements will be trained on an "as needed" basis. Training venues will include Grand Rounds, seminars and special in-service sessions.



## 8. RADIATION PRODUCING MACHINES

The Radiation Safety Department (RSD) oversees all Federal and State rules and regulations with respect to radioactive materials and radiation producing machines within West Virginia University (WVU) and West Virginia University Hospitals (WVUH). The RSD renders its services as the liaison between departments and relevant regulatory agencies to effectively establish and maintain all of the necessary regulatory obligations according to the rules and regulations. The RSD is required to register every radiation producing machine with West Virginia State Radiological Health (WVSRH) in adherence to the rules and regulations prior to use.

The RSD has developed the following procedures as an aide in maintaining compliance with regulations governing the registration and use of radiation producing machines with the WVUH. Compliance with rules and regulations pertaining to medical radiation producing machines as mandated by the institution lies with each individual user of radiation producing machines. The RSD will have ultimate responsibility and authority to assure that these regulations are being followed.

### 8.1 GENERAL SAFETY PROCEDURES

- A. Radiation producing machines shall be operated only by qualified personnel.
- B. Radiation warning signs must be placed so as to prevent personnel from entering the radiation area. The signs should indicate clearly the type of radiation hazard present. Signs should be removed when there is no longer any need for them. In certain instances, other precautions, such as locking the entrances to the room and interlocks, may be advised or required.
- C. Areas in which radiation producing machines are located or are in use shall be posted with the characteristic “Caution Radiation” sign. In addition, the controls shall bear a decal with the statement: “Caution Radiation – This equipment produces radiation when energized.” Labels and decals are available from the RSD.
- D. The operator must never be exposed to the direct beam of a radiation producing machine and must not stand within four (4) feet of the tube or irradiated target while the machine is in operation, unless adequately shielded.
- E. Unless measurements indicate that they are not needed, protective aprons shall be worn by the physician, nurse, technologist, and all other persons within the room or area who are frequently or habitually exposed to radiation.

- F. All protective devices that may become defective due to use or abuse, such as protective lead aprons or gloves, should be inspected for radiation leakage annually or whenever the integrity of the equipment is suspect.
- G. Allowances must be made for the range of the radiation. For example, when the beam is directed across the room, the radiation will extend into adjoining rooms. Protective barriers, lead aprons, and gloves should be used. The dose in any unrestricted area shall not exceed 0.02 mSv (2 mrems) in any one hour. The total effective dose equivalent to individual members of the public shall not exceed 1 mSv (100 mrems) in a year.
- H. Any restrictions or recommendations on the use of the machines made by the RSO must be observed.
- I. The radiation exposure to the patient should be the minimum exposure required to produce images of good diagnostic quality.
- J. The speed of film or screen and film combinations, should be the fastest speed consistent with the diagnostic objective of the radiographic examination.
- K. During a radiographic examinations, the x-ray field shall be collimated to dimensions no greater than those of x-ray film.
- L. When a patient or film must be provided with auxiliary support during a radiation exposure;
  - 1. Mechanical holding devices shall be used when the technique permits.
  - 2. Individuals may be used to hold a patient only when absolutely necessary, and no individual shall be used routinely for this purpose to the exclusion of others who might share the task.
  - 3. If a human holder is required, the holder shall be positioned such that no part of the body will be struck by the primary x-ray beam unless protected by at least 0.5 millimeter lead equivalent, and shall be protected from the direct scatter radiation by a protective apron of not less than 0.25 millimeter lead equivalent.
- M. Gonadal shielding of not less than 0.25 millimeter lead equivalent shall be used for patients who have not passed the reproductive age during radiographic procedures in which the gonads are in the primary x-ray beam, except in cases in which the shield would interfere with the diagnostic procedure.

- N. Personnel monitoring devices will be issued to any individual who is likely to receive more than 10% of the permissible dose limit or operate fluoroscopic equipment.
- O. All operating personnel and personnel in the immediate area will be required to wear a film badge or other personnel monitoring device.
- P. Individuals shall not be exposed to the primary x-ray beam except for healing arts purposes, and such exposure shall be authorized by a licensed practitioner of the healing arts. This specifically prohibits deliberate exposure of an individual for training demonstration, or other non-healing arts purposes.
- Q. The doors of the x-ray room should be closed before making an x-ray exposure.
- R. No patient should wait or change in the x-ray room while another patient is being radiographed.
- S. Except for patients who cannot be moved out of the room, only the staff and necessary personnel required for the medical procedure shall be in the room during the radiographic exposure. Other than the patient being examined:
  - 1. All individuals shall be positioned such that no part of the body will be struck by the useful beam unless protected by at least 0.5 millimeter lead equivalent.
  - 2. Staff and ancillary personnel shall be protected from the direct scatter radiation by protective aprons or whole body protective barriers of not less than 0.25 millimeter lead equivalent. The aprons shall be wrapped around if x-ray exposure to the back, if possible.
  - 3. Patients who cannot be removed from the room shall be protected from the direct scatter radiation by protective barriers of not less than 0.25 millimeters lead equivalent or shall be so positioned that the nearest portion of the body is at least two (2) meters from both the tube head and the nearest edge of the image receptor.
- T. In the operation of mobile units; the operator should stand as far as possible from the tube and patient during exposure, and should wear a protective apron, or step behind an adequate shield.
- U. All x-ray machines shall be surveyed by a qualified physicist annually.
- V. Notify the supervisor and RSO immediately of any unusual exposures to radiation.

- W. Should any female working with a radiation producing machine decide to declare their pregnancy, the “*Declaration of Pregnancy*” form shall be used and she shall meet with the RSO to discuss how to minimize her exposure.

## **8.2 PURCHASING/LEASING RADIATION PRODUCING MACHINE**

Prior to purchasing any new piece of x-ray generating equipment, interested individuals must contact the RSO (RSO) in writing, providing all pertinent information regarding the type of equipment needed. This should include intended use, location, equipment description, and proposed vendor. In addition;

- A. Inform the RSD of the purchasing/leasing plan;
- B. Describe the nature, duration, and scope of use of the machine; and
- C. Submit information on the type of radiation machine (make, model, serial number) and the intended locations where the machine is to be used.

## **8.3 SHIELDING DESIGNS**

- A. Prior to purchase, drawings and plans for all necessary shielding must be submitted to the RSO for approval by the appropriate Radiation Safety Committee. The following must be considered;
  - 1. Does the machine require shielding housing? If yes, provide information on
    - i. Who will do the shielding design and are they an outside consultant/vendor?
    - ii. Is the consultant/vendor registered on the WV State Radiological list?
    - iii. Submit a floor plan indicating the x-ray work area, machine position, amount of lead in the walls, and functions on the other side of the walls.
  - 2. Provide the copy of the shielding design to the RSD. The shielding design shall;
    - i. Indicate the use of area adjacent to the x-ray room with an estimation of the extent of occupancy by individuals in such areas;
    - ii. Include a scale drawing of all rooms containing a stationary radiation machine, machines location, and maximum rated technique factors; and
    - iii. Include the type and thickness of materials, or lead equivalency of each wall or protective barrier.
- B. The structural shielding requirements of any new installation, or an existing one in which changes are contemplated, shall be discussed with the RSD, in writing.
- C. If there is any change within existing shielding design, inform the RSD immediately.

- D. The recommendations in the following National Council on Radiation Protection (NCRP) Reports may be useful when designing facilities and procedures for radiation producing machines. Copies are available from the Radiation Safety Department.
1. NCRP Report No. 49-Structural Shielding Design and Evaluation for Medical Use of X-Rays and Gamma Rays of Energies Up to 10 MeV
  2. NCRP Report No. 51-Radiation Design Guidelines for 0.1 – 100 MeV Particle Accelerator Facilities
  3. NCRP Report No. 102-Medical X-Ray, Electron Beam and Gamma-Ray Protection for Energies up to 50 MeV (Equipment Design, Performance and Use)

#### **8.4 INSTALLATION**

- A. The installer is required to submit a Report of Assembly, FDA Form 2579, to the WV State and Purchaser.

#### **8.5 REGISTRATION**

- A. All Radiation Producing Machines possessed/leased in the WVUH are required to be registered with WWSRH. The RSD will register it according to the rules and regulations in State of WV and WVU RSD policy and procedure.
- B. All state registration certificates must be posted in the room where the radiation machine is located.
- C. Departments shall notify the RSD, in writing, within five (5) days, after any change which renders the information on the registration no longer accurate (Room Numbers, Make, Model, Serial Number of the radiation device). In the case of out-of-service of radiation devices, such notification must be reported immediately and in case of surplus specify the recipient of these radiation producing device.

#### **8.6 INSPECTIONS**

Periodic surveys of all radiation producing machines and areas in which these machines are located will be conducted by the RSD. These surveys are in addition to (not in lieu of) the surveys and other requirements listed below for the use of radiation producing machines. Diagnostic X-Ray machines will be inspected annually by a representative of the West Virginia Department of Health (WVDOH). All radiation producing machines are required to be registered with the WVDOH.

- A. After installations RSD will inspect all radiation safety aspects of the operational procedures. All radiation producing machines must be surveyed prior to routine use and at one year intervals. A dosimetry badge should be worn by those in the vicinity when the

machine is in use unless it is totally contained within adequate shielding.

- B. RSD will conduct environmental surveys and inspections according to RSD policies and procedures.
- C. Periodically, the RSD will request an inventory of all x-ray generating equipment be taken. These records will be kept on file and will aide in ensuring that information is current and accurate.
- D. WV State inspection is conducted every three years.

### **8.7 MANAGEMENT**

- A. The Registration Certificate posted in the room where the radiation device is located.
- B. The “Notice to Employees” is posted in the room where the radiation device is located.
- C. Ensure that required signs and notices are properly posted.
- D. Ensure that personal monitoring devices are used as required.
- E. If any changes have been made since last certification, inform RSD immediately.
- F. Physics report must be conducted by registered qualified expert annually or after any maintenance of the system which might affect the exposure rate.
- G. Equipment maintenance/modification record must be present.

### **8.8 RADIATION SAFETY FOR FLUOROSCOPISTS**

Radiation exposure during fluoroscopy is directly proportional to the length of time the unit is activated by the foot switch. Unlike regular x-ray units, fluoroscopic units do not have an automatic timer to terminate the exposure after it is activated. Instead, depression of the foot switch determines the length of the exposure, which ceases only after the foot switch is released. Fluoroscopy machines are equipped with a timer and an alarm which sounds at the end of five (5) minutes. The alarm serves as a reminder of the lapsed time and can then be reset for another five (5) minutes. To keep doses ALARA the following procedures have been put in place:

- A. Personal monitoring dosimeters shall be worn at their respective positions at all times during the fluoroscopy procedure.

- B. The surgeon shall be aware of the exposure levels associated with the various modes of operation.
- C. Indication of the kVp and mA in use should be visible to the surgeon.
- D. The control panel shall provide positive audible and visual indication of the production of x-rays whenever the x-ray tube is energized.
- E. Protective aprons of at least 0.5mm lead equivalent and thyroid shield shall be worn during fluoroscopy procedure at all times.
- F. Lead-glass eye shields and radiation-attenuating surgical gloves should be utilized by the surgeon to reduce radiation exposures.
- G. Shielding devices, such as table side shields, shall be provided to minimize over-table scattered radiation reaching the surgeon.
- H. The hands of the surgeon shall not be placed in the useful beam unless the beam is attenuated by the patient and the surgeon is wearing protective gloves of at least 0.25mm lead equivalent.
- I. No person should routinely hold patients during fluoroscopy procedures. If a patient must be held by a surgeon, he/she shall be protected with appropriate shielding devices, such as attenuating surgical-gloves and aprons.
- J. Particular care should be taken to align the x-ray beam with the patient and image receptor.
- K. The useful beam shall be limited to the smallest area practicable and consistent with objectives of the fluoroscopy examination or treatment.
- L. Mobile fluoroscopy should be performed under the immediate supervision of a radiologic technologist who is properly trained in fluoroscopic procedures.
- M. The beam ON-time shall be kept at a minimum.
- N. The II should be kept as close to the patient as possible, and the tube as far as possible.
- O. The surgeon should consider decreasing the number of cases that involve the use of fluoroscopy.

## 8.9 COMPUTER TOMOGRAPHY RADIATION SAFETY

Radiologists, radiologic technologists, and all supervising physicians have a responsibility to keep radiation doses ALARA to individual patients and staff, while maintaining the necessary diagnostic image quality.

Facilities, in consultation, with the RSO should have in place and should adhere to policies and procedures, in accordance with ALARA, to vary examination protocols to take into account patient body habitus, such as height and/or weight, body mass index or lateral width. The dose reduction devices that are available on imaging equipment should be active; if not, manual techniques should be used to moderate the exposure while maintaining the necessary diagnostic image quality.

- A. The registrant shall obtain a written report of the survey from the qualified expert and a copy of the report shall be made available to the agency upon request.
- B. The calibration of the radiation output of the CT x-ray system shall be performed by, or under the direction of, a qualified expert who is physically present at the facility during such calibration.
- C. The calibration of a CT x-ray system shall be performed at intervals specified by a qualified expert and after any change or replacement of components which, in the opinion of the qualified expert, could cause a change in the radiation output.
- D. The calibration of the radiation output of a CT x-ray system shall be performed with a calibrated dosimetry system. The calibration of such system shall be traceable to a national standard. The dosimetry system shall have been calibrated within the preceding two (2) years.
- E. CT dosimetry phantoms shall be used in determining the radiation output of a CT x-ray system. Such phantoms shall meet the following specifications and conditions of use.
- F. The operator shall be able to terminate the x-ray exposure at any time during a scan, or series of scans under CT x-ray system control, of greater than one-half second duration.
- G. For any single tomogram system, means shall be provided to permit visual determination of the tomographic plane or a reference plane offset from the tomographic plane.
- H. The CT x-ray control and gantry shall provide visual indication whenever x-rays are produced and, if applicable, whether the shutter is open or closed.



- I. Each emergency button or switch shall be clearly labeled as to its function.
- J. Provision shall be made for two-way aural communication between the patient and the operator at the control panel.
- K. Windows, mirrors, closed-circuit television, or an equivalent shall be provided to permit continuous observation of the patient during irradiation and shall be so located that the operator can observe the patient from the control panel.
- L. When the primary viewing system is by electronic means, an alternate viewing system (which may be electronic) shall be available for use in the event of failure of the primary viewing system.
- M. All CT x-ray systems installed after July 1, 2000 and those systems not previously surveyed shall have a survey made by, or under the direction of, a qualified expert. In addition, such surveys shall be done after any change in the facility or equipment which might cause a significant increase in radiation hazard.
- N. CT dosimetry phantoms shall provide means for the placement of a dosimeter or dosimeters along the axis of rotation and along a line parallel to the axis of rotation one (1.0) centimeter from the outer surface and within the phantom. Means for the placement of dosimeters or alignment devices at other locations may be provided.
- O. Any effects on the doses measured due to the removal of phantom material to accommodate dosimeters shall be accounted for through appropriate corrections to the reported data or included in the statement of maximum deviation for the values obtained using the phantom.
- P. All dose measurements shall be performed with the CT dosimetry phantom placed on the patient couch or support device without additional attenuation materials present.
- Q. The calibration shall be required for each type of head, body, or whole-body scan performed at the facility.

NOTE: The recommended diagnostic CT reference levels below were derived from analysis of the data gathered from the first three (3) years of the ACR CT Accreditation Program. This recommendation must be posted at all times at the console of any CT scanner Console.

Examination	Reference Level (CTDIvol)
CT Head	75 mGy
CT Adult Abdomen	25 mGy

CT Pediatrics Abdomen (5 years old)	20 mGy
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### **8.9.1 TO REDUCE CT DOSE**

- A. Eliminate unnecessary CT use;
- B. Raise referring physicians' awareness;
- C. Consider alternative diagnostic tools; and
- D. Optimize imaging protocols.

### **8.9.2 FACTORS THAT CAN INCREASE DOSE**

- A. Thinner slices;
- B. Higher spatial resolution; and
- C. More slices.

### **8.9.3 TECHNIQUES THAT CAN REDUCE DOSE**

- A. Lowering tube current;
- B. Using lower kVp during pediatric exams;
- C. Scanning only what you need;
- D. Using multiple-phase scanning only if needed; and
- E. Using CT-specific organ shielding.

### **8.9.4 TECHNIQUES THAT DON'T ALWAYS REDUCE DOSE**

- A. Faster tube rotation;
- B. Increasing the pitch; and
- C. Use of patient-specific dose control.

### **8.9.5 INSPECTION**

The RSD is required by the WV Radiological Health Program, and its policy, to inspect the radiation safety program of each registration every year. The review of the Radiation Protection Program is documented, at least annually, for content and accuracy with signature and date by a responsible party (i.e. RSO, or a licensed practitioner of the healing arts). The inspection consists of, but is not limited to:

- A. Management of Device
  - 1. Posting requirements:
    - i. Registration and the "Notice to Employees."
    - ii. Application sections of the Radiological Health Rule or a notice which describes the document and states where it may be examined.

- iii. “Caution Radiation Area” signs at entrance to any radiation areas were radiation exposures may exceed 5 mrem in one hour.
2. Training is provided and documented for operators operating the x-ray equipment by the State and/or vendor.
3. Portable radiographs should be done only when it is impractical to bring the patient to the stationary x-ray room and that all patients, staff, and x-ray operators in a nine (9) foot radius of the tube and image receptor are being removed from the area or being protected with a lead-lined barrier.
4. The x-ray facility should have protective lead apparel and gloves in sufficient numbers to provide to adequate protection for the patient and operator.

#### B. Radiation Protection Program: Patient Utilization Log

1. X-ray procedures are documented, maintaining a record of the patient’s name, the type of examination, and the dates the examination was performed.
  - i. Is the Human Holder Log present and current?
  - ii. Are written procedures available to determine the human holder selection process?
  - iii. Are human holder’s instructed in personal radiation safety?
2. Record of “Human Holders”: names are recorded for anyone who provides auxillary support to the patient or film, used only when mechanical holding devices cannot be used. Written procedures are available to determine the human holder selection process such that no individual is routinely used. All human holder’s must be instructed in personal radiation safety and protected with a minimal of  $\geq \frac{1}{2}$  mm lead equivalent material for primary radiation protection ensuring that no part of the body is being struck by the primary beam. Names of the human holders are recorded on a patient/utilization chart or separate log.

#### C. Individual Radiation Monitoring Device

1. Employee has and wears his/her monitoring device at all times?
2. Are readings for the monitoring devices present?
3. Are there any “Declared Pregnant Workers?”
4. Are two (2) monitoring devices being worn?

#### D. X-Ray Operator’s Control Panel

1. Does the radiation machine bear the warning state “Warning: This x-ray unit may be dangerous to patient and operator unless safe exposure factors and operating instructions are observed?”
2. Is the exposure switch or x-ray control location in a protected area?

## 9. MEDICAL USE OF RADIATION AND RADIONUCLIDES

### 9.1 GENERAL PROCEDURES FOR PHYSICIANS

#### 9.1.1 SEALED SOURCE IMPLANTS

- A. It is the physician's responsibility to request a private room for all sealed source therapy patients (Cs-137, Ir-192, I-125).
- B. Procurement of all sources follows the procedure in Section 4. The radionuclide requisition must be filled out and signed by the Authorized User, then brought to the Radiation Safety office to obtain the purchase order number.
- C. All personnel participating in the procedure must be familiar with and comply with the Radiation Oncology quality Management Program. Copies of the program are available from the radiation oncology physicist or chief technologist.
- D. The Radiation Safety Department must be informed of all implants so that the necessary warning signs and labels can be posted and shields prepared. These will be removed by RSD personnel after the sources are removed, counted, and the patient surveyed.
- E. Each patient must be restricted to his or her room during the therapy treatment. An exception may be made for some patients treated with I-125 seeds.
- F. Each patient must remain hospitalized until the sources are removed, or in the case of permanent implants, the radiation level is low enough to be no hazard to those in the home.
- G. The Chief of Radiation Oncology has responsibility for insertion and removal of sources, and for ensuring that the sources are properly inventoried. The sources must be inventoried at the time of insertion or immediately afterward.
- H. A log book of issues and return must be maintained as a part of the inventory procedure. The inventory must be performed directly after removal of the sources. Therefore, sources will either be in the patient or in inventory, and not temporarily stored somewhere in between.
- I. The following information must be in the patient's chart:
  - 1. Radionuclide;
  - 2. Total activity in millicuries and number of sealed sources;
  - 3. Location in body;

4. Date of insertion and anticipated date of removal.

### **9.1.2 RADIONUCLIDE ADMINISTRATION-PATIENTS REQUIRING HOSPITALIZATION**

- A. Patients receiving a therapeutic dose of more than 30 mCi of a radionuclide AND are expected to present an estimated dose to others of greater than 5 mSv (500 mrem) must be hospitalized in a private room with a private bath for radiation protection purposes.
- B. Contact the RSD before administration so that arrangements can be made to provide absorbent paper for the room or any other precautions which may be necessary. RSD personnel will provide the necessary warning signs and labels and survey the patient after administration.
- C. Administer the radiopharmaceutical in the patient's room taking precautions discussed in the "Diagnostic Dose" section below.
- D. All personnel participating in the procedure must be familiar with and comply with the appropriate Quality Management Program. Copies of the program are available from the chief technologist.
- E. The chief technologist is responsible for safe disposal of all radioactive solutions and contaminated equipment. Such solutions and equipment are not to be left on the nursing unit or disposal responsibility relegated to the nursing staff.
- F. The following information must be on the patient's chart:
  1. Radionuclide and number of millicuries
  2. Location in body
  3. Date administered
- G. Each patient must be restricted to his/her room during the therapy treatment.
- H. All wastes generated from the patient's room must be handled properly:
  1. Bodily waste (urine, feces, vomit) may be disposed of via the toilet.
  2. Other wastes such as contaminated syringes, etc. must be bagged and marked as described in Section 11, "Radioactive Waste Disposal."
  3. Contaminated return items:
    - i. Hold these for decay whenever possible
    - ii. Decontaminate items if necessary
- I. RSD will assist and monitor materials leaving the room. The use of disposable items is encouraged.
- J. Any tissue samples, blood, excreta, etc. that are contaminated must be marked with a "Caution - Radioactive Material" sticker and any special handling instructions forwarded to the analyzing laboratory. Assistance in determining the above is available from the

RSD.

- K. Each patient must remain hospitalized until the residual activity is less than 30 millicuries or the measured dose rate at 1 meter is less than the corresponding value in Table 3: Activities and Dose Rates for Authorizing Patient Release (table follows section). Consideration should be given to possible exposure of other family members at home, especially children and pregnant women.
- L. The radiation warning sign(s) on radioactive patient rooms will be removed by the RSD when:
- The patient is discharged; or
  - The residual activity is below 5 millicuries; or
  - The exposure rate is less than the value established by Table 1.
- M. When a patient containing residual activity leaves the hospital, the physician must give written instructions on how to minimize exposures to others if the dose to an individual exposed to the patient is likely to exceed 1 mSv (100 mrem). The RSD will assist in this.

**Table 3: Activities and Dose Rates for Authorizing Patient Release †**

Radionuclide	COLUMN 1 Activity at or Below Which Patients May Be Released		COLUMN 2 Dose Rate at 1 Meter, at or Below Which Patients May Be Release*	
	(Gbg)	(mCi)	(mSv/hr)	(mrem/hr)
Ag-111	19	520	0.08	8
Au-198	3.5	93	0.21	21
Cr-51	4.8	130	0.02	2
Cu-64	8.4	230	0.27	27
Cu-67	14	390	0.22	22
Ga-67	8.7	240	0.18	18
I-123	6.0	160	0.26	26
I-125	0.25	7	0.01	1
I-125 implant	0.33	9	0.01	1
I-131	1.2	33	0.07	7
In-111	2.4	64	0.2	20
Ir-192 implant	0.074	2	0.008	0.8
P-32	**	**	**	**
Pd-103 implant	1.5	40	0.03	3
Re-186	28	770	0.15	15
Re-188	29	790	0.2	20
Sc-47	11	310	0.17	17
Se-75	0.089	2	0.005	0.5
Sm-153	26	700	0.3	30
Sn-117m	1.1	29	0.04	4
Sr-89	**	**	**	**
Tc-99m	28	760	0.58	58
Tl-201	16	430	0.19	19
Y-90	**	**	**	**
Yb-169	0.37	10	0.02	2

†The activity values were computed based on 5 millisieverts (0.5 rem) total effective dose equivalent.

\* If the release is based on the dose rate at 1 meter in Column 2, the licensee must maintain a record as required by 10 CFR 35.75(c) because the measurement includes shielding by tissue. See Regulatory Position 3.1, "Records of Release," for information on records.

\*\* Activity and dose rate limits are not applicable in this case because of the minimal exposures to members of the public resulting from activities normally administered for diagnostic or therapeutic purposes.

**NOTES:**

The millicurie values were calculated using Equations 2 or 3 and the physical half-life. The gigabecquerel values were calculated based on the millicurie values and the conversion factor from millicuries to gigabecquerels. The dose rate values are calculated based on the millicurie values and the exposure rate constants.

In general, the values are rounded to two significant figures. However, values less than 0.37 gigabecquerel(10 millicuries) or 0.1 millisievert (10 millirems) per hour are rounded to one significant figure. Details of the calculations are provided in NUREG-1492 (Ref. 2).

Although non-byproduct materials are not regulated by the NRC, information on non-byproduct material is included in this regulatory guide for the convenience of the licensee.

Agreement State regulations may vary. Agreement State licensees should check with their State regulations prior to using these values.

### **9.1.3 RADIONUCLIDE ADMINISTRATION-PATIENTS NOT REQUIRING HOSPITALIZATION**

- A. Patients receiving a therapeutic dose of a radionuclide who are not required to be hospitalized, and are being sent home, must be given radiation safety instructions to be observed at home. The physician ordering the treatment is responsible for seeing that this instruction is given; specific instructions may be developed in consultation with Radiation Safety.
- B. Some patients who receive a therapeutic dose of a radionuclide may not require hospitalization because of the dose administered but may be required to stay in the hospital because of some other condition. In this case, the physician must also inform the Radiation Safety office so that Radiation Safety personnel can give instructions on radiation safety precautions that should be observed by those attending the patient.
- C. When the patient has a private room, radionuclides should be administered in the patient's room; otherwise, a treatment room is preferable.
- D. Follow the other precautions discussed in the "Diagnostic Dose" section below for administration of the radionuclide.

### **9.1.4 RADIONUCLIDE ADMINISTRATION-DIAGNOSTIC DOSES**

- A. Wear laboratory coats or other protective clothing at all times in areas where radioactive materials are used.
- B. Wear disposable gloves at all times while handling radioactive materials.
- C. The patient, if wearing street clothes, must be suitably protected from accidental contamination with a lab coat, sheet, etc.
- D. If contamination of the floor or table top is likely, absorbent mats should be used to reduce decontamination work.
- E. It is strongly recommended that disposable syringes and needles be used whenever possible. Use syringe shields for routine preparation of multi-dose vials and administration of radiopharmaceuticals to patients, except in those circumstances in which their use is contraindicated (e.g., recessed veins, infants).
- F. Each syringe or syringe shield must display the radiopharmaceutical name or its abbreviation, the clinical procedure to be performed, or the patient's name.
- G. Either after each procedure or before leaving the area, monitor your hands for contamination in a low-background area with a suitable instrument such as a crystal probe or camera.



### **9.1.5 EMERGENCY SURGERY**

The physician or resident must:

- A. Inform the surgeon of:
  - 1. The date of the radionuclide therapy,
  - 2. The amount and kind of radionuclide,
  - 3. The location of the radionuclide in the patient.
  
- B. Inform the RSD before the surgery of:
  - 1. The above information,
  - 2. The time and place of surgery.
  
- C. The Radiation Safety Department will provide necessary monitoring and advice on exposure.

### **9.1.6 CADAVERS**

- A. If a patient who has received a therapeutic dose of any radionuclide dies in the hospital within a three week period after administration, the physician must:
  - 1. Notify the Radiation Safety office, night or day. The RSO will give suitable instructions to the pathologist and funeral director.
  - 2. Notify the pathologist, if an autopsy is to be performed, that the cadaver contains radioactive material and that the Radiation Safety office will provide necessary monitoring during autopsy.

Refer to NCRP Report 37 for additional information concerning radioactive cadavers and/or the death of a radioactive patient.

## **9.2 GENERAL PROCEDURES FOR NURSES**

### **9.2.1 RADIOTHERAPY PATIENT**

A radiotherapy patient is defined as a patient who has been given radionuclides orally or intravenously or has received a sealed source implant. Specifically excluded are patients who have been irradiated only by x-ray or accelerator machines. These latter patients will not contain any residual radioactivity from the x-ray or accelerator treatments. Consequently no special precautions are necessary as they do not present any radiation hazard. Patients who have received diagnostic doses of radiopharmaceuticals also do not require any special precautions. For caregiver guidelines regarding the most common procedures with potential for radiation exposure, see Appendix 4.

### **9.2.2 TYPES OF HAZARDS**

Radiation hazards may arise by four means:

- A. External irradiation due to radionuclides or radiation sources in the patient.
- B. Contamination of the skin in the course of patient care (for radionuclides).
- C. Ingestion of radioactive material (probably from hands contaminated from radionuclides).
- D. Inhalation of volatile radioactive materials.

### **9.2.3 RADIATION PROTECTION PROCEDURES**

The following procedures are given in order to keep radiation exposure to nursing personnel as low as is reasonably achievable:

- A. Nurses who are pregnant must not be assigned to radiotherapy patients.
- B. It is the physician's responsibility to have all therapy patients housed in a private room if they have received sealed source implants or have been administered more than 30 millicuries of a radionuclide. The most desirable room is the isolation room, followed by the end rooms with side walls on the outside of the building.
- C. A patient who has been administered radionuclides or sealed source implants can be identified by:
  1. A "Temporary Implant" or "Permanent Implant or Internal Dose" sticker on the front cover of the patient's chart and information in the chart.
  2. A "Caution - Radiation Area" or "Caution - Radioactive Materials" sign on the patient's door.
- D. The sticker and signs are placed there by a person from the Radiation Safety office. Neither may be removed except by a representative of the Radiation Safety office.
- E. A written training module or a videotape will be provided to answer questions nursing personnel may have regarding care of radioactive patients. Nursing personnel should review these before administering care to these patients.
- F. Specific instructions for each patient will be posted on the door or in the patient's chart.
- G. Additional questions may be directed to the Radiation Safety representative assigned to the patient or to the RSD. A member of the Radiation Safety staff is always on call and carries pager number (304) 987-1586.
- H. Film badges or other radiation dosimeters will be provided for personnel caring for the radiation therapy patient; these must be worn during the entire shift. Each person must sign for his or her own film badge and not wear anyone else's. These will be collected after the patient is discharged.

- I. The trash can in the radiotherapy patient's room is kept lined with a plastic bag. This will facilitate the radiation survey of the trash.
- J. Limit each visitor to the length of time indicated by the RSD for that procedure.
- K. For additional information, see the previous section "General Procedures for Physicians."

#### **9.2.4 PREVENTION OF UNNECESSARY EXTERNAL IRRADIATION**

- A. Do not neglect the patient, but do not linger unnecessarily either.
- B. Keep as much distance as possible between the patient and yourself while working in the room; the further away the patient is, the less the exposure rate will be. If a bedside shield is provided, work behind it as much as possible.
- C. Unless specifically ordered by the doctor, the patient's bath should be postponed for the first 48 hours. Thereafter, baths may be given every second day for the first week. However, the patient may bathe himself or herself as often as desired unless restricted by the doctor.
- D. For patients with sealed source implants (Ir-192, Cs-137, etc.):
  - 1. Linen, trash, etc. should be left in the patient's room until surveyed by Radiation Safety office personnel.
  - 2. If a sealed source becomes displaced, contain the source in the lead container left in the room **WITHOUT TOUCHING IT** with your fingers. Use forceps or other handling devices to keep the source at least 6 - 12 inches from your hands and body. Notify the physician and the Radiation Safety office at once.
  - 3. The room is not to be cleaned by housekeeping or released for other patients until it has been surveyed by Radiation Safety office personnel and all warning signs have been removed. A sticker which says "OK - Radiation Safety Department" is left on or adjacent to the door after the survey.
  - 4. Gynecological patients are restricted to bed during the therapy treatment. Patients receiving other types of radiotherapy should be either in bed or on the far side of the bed when staff or visitors are in the room.
  - 5. Exception: Patients who have been implanted with I-125 seeds in the prostate or brain represent minimal threat from external radiation. The radiation that gets through the body from the implanted seeds is so weak that the patient may be allowed to walk the corridor before being discharged. The seeds themselves may become dislodged, however, and should not be handled except as indicated above.
  - 6. Surgical dressings and bandages should be changed only as directed by the physician. This is one of the more likely places for dislodged sources to appear.
  - 7. Barring a rupture of one of the sealed sources, instruments and containers used to handle them do not become radioactive.

8. Perineal care is not normally given during the treatment, but the perineal pad may be changed when necessary. If the pad is changed, be sure the radioactive sources are not disturbed. Should a bowel movement necessitate perineal care, it should be given with due consideration to distance, time and shielding.

### **9.2.5 PREVENTION OF CONTAMINATION AND INGESTION**

- A. This is normally only a problem for patients administered volatile radionuclides like I-131 and is not a problem in sealed source therapy unless one of the sources has ruptured (rupture of a source would be extremely unusual).
- B. If there is leakage from an intracavity injection or spillage of radioactive vomitus or urine, put on surgical gloves and mask and try to contain the liquid without directly touching it. Use paper towels or other disposable absorbent materials if immediately available. Keep the gloves with other contaminated material for monitoring. Notify the responsible physician and the Radiation Safety office at once. In the meantime, keep those not involved away from the area so as to prevent spread of the contamination.
- C. Urine and feces may be disposed of in the toilet. If a bedpan is used, it must be handled by hospital personnel wearing gloves, gown and mask. The bedpan may be rinsed and the rinse water disposed of via the toilet. Keep the same bedpan for use until the treatment is completed; it will be checked for contamination at that time.
- D. Disposable dishes and utensils should be used for the patient's meals. No linen or trash should leave the room until it has been checked by Radiation Safety office personnel.
- E. Radioactive material should not be allowed to touch the skin. Wear disposable gloves whenever contact is possible.
- F. Practice good housekeeping when working with radiotherapy patients. Wash hands thoroughly before eating or engaging in any other hand-to-mouth activity following care of the patient.
- G. When a patient is first administered I-131, practically anything he or she touches will be contaminated by radioactive perspiration. Also, as much as 80% of the iodine may appear in the urine during the first 48 hours. Therefore, wear disposable gloves when changing the bed linen, touching the patient or other activities. Put a plastic or rubber cover on the pillow and materials during the first 48 hours (at least) to prevent contamination of these items.

### **9.2.6 SUMMARY**

- A. Do not neglect patient care.
- B. Wear your film badge.

- C. Keep as much distance as possible between you and the patient; perform the necessary duties in a little time as possible.
- D. Nothing should be removed from the patient's room unless it has been monitored by a person from the Radiation Safety office.
- E. Use disposable gloves when handling any items that might be contaminated.
- F. Call the physician in charge and the Radiation Safety office if a spill occurs or a loose source is found.
- G. For additional information, refer to "Radiation Safety Precautions for Patients" or contact the Radiation Safety office.

### **9.3 GENERAL PROCEDURES FOR RADIATION PRODUCING EQUIPMENT OPERATORS**

#### **9.3.1 DIAGNOSTIC AND THERAPEUTIC X-RAY UNITS**

- A. Notify the RSD whenever there is any change in the setup; i.e., new equipment, change in output of radiation, change in shielding, etc.
- B. Always wear your film badge.
- C. Keep your exposure as low as possible. The operator must never expose himself or herself to the useful beam. Make full use of protective barriers, lead aprons, and gloves.
- D. Clear the area of all non-essential personnel. The operator shall insist that all non-essential personnel leave the exposure area before operating the unit, and that all essential personnel be adequately shielded.
- E. Notify the supervisor and the RSD immediately of any accidental exposures to radiation.
- F. Keep the unit disconnected or locked when not in actual use.
- G. No person shall be regularly employed to hold patients during exposure, nor shall any x-ray technologist or student technologist ever be permitted to perform such service.
- H. All protective devices that may become defective with use, such as lead aprons or gloves, must be periodically inspected for radiation leakage.

#### **9.3.2 HOLDING PATIENTS FOR X-RAY EXAMINATIONS**

No person shall be regularly employed to hold patients during x-ray exposures. A parent or other relative may hold the patient if this is necessary. At other times a nurse may be asked to hold a patient for an x-ray. The holder must do the following:

- A. Wear a film badge or pocket chamber (if provided).
- B. Wear a lead apron and gloves (if gloves are provided).
- C. Never place any part of his or her body in the useful beam of the x-ray machine.

**9.4 EMERGENCY SURGERY**

Patients who have received temporary sealed source implants must have them removed before having surgery. Once they have been removed, no radiation precautions will be required for the surgery itself unless somehow there has been a rupture of a source (which is extremely unlikely).

If the patient does not contain more than 5 mCi of any radionuclide, surgery may be performed with no attention to the radioactivity. Larger quantities may be present in patients with radioactive colloid in a cavity or injected into tissues, with radioactive iodine for a thyroid condition, or with metallic radioactive implants. In these cases certain precautions may be necessary.

- A. Radioactive Iodine - It is highly unlikely that emergency surgery will be essential within 24 hours after the administration of a dose. After this period, if the surgeon can avoid actual manipulation of the thyroid gland or of regions containing active metastases, he or she will not receive an undue exposure during the period of any likely emergency operation.
- B. Radioactive Colloidal Chromic Phosphors in Pleural or Abdominal Cavity The radionuclide will be deposited more or less uniformly over all the serous surfaces, and when the body is unopened, the P-32 betas are largely absorbed by the superficial tissues of the body. Once the body is opened, the surgeon's hands and face (if the body is opened widely) may be exposed to relatively intense beta radiation\*.
- C. Colloidal or Metallic Radioactive Implants in Tissues. It is usually possible to avoid direct contact with the implanted region. There is little use in trying to block the radiation by shielding. For high energy gamma-emitting nuclides (such as Cs-137) lead aprons or sheets are of little value. It is more important for everyone on the surgical team to stand as far as practicable from the radioactive material.

\*Beta radiation may be attenuated by providing shielding between the source and the surgeon. The use of gloves can reduce the shallow-dose equivalent significantly as is shown in the following table.

<u>Dose rate in mrems/hour from 1 mCi of P-32</u>		
No Gloves	Single Surgical Gloves	Double Autopsy Gloves
800	600	300

At these dose rates, the shallow-dose equivalent limit may be approached in some surgical procedures. The Radiation Safety Department must be consulted to advise on ways to limit doses during surgery.

Glasses or goggles should be worn by the surgeon and assistants to protect against a possible splash of radioactive material into the eyes, as well as from beta radiation.

## **9.5 DEATH**

The physician who pronounces the patient dead and sends the body to the morgue must make sure that a radioactivity label remains affixed to the history and accompanies the body if it contains more than 5 mCi of a radionuclide. He or she should also attach blank copies of a suitable radioactivity form to the death certificate, to the patient's chart, and to the autopsy permission slip if there is one.

The physician should notify the Radiation Safety Department so that Radiation Safety personnel can provide instructions for handling the body to those who come into contact with it.

To set down here details of procedure for autopsy or embalming would be simply to copy NCRP Report No. 155 Section 6. It is evident that if the radionuclide content is above 5 mCi the RSO will have to be involved in autopsy procedure, and if more than 30 mCi, must be present for either embalming or autopsy. Copies of NCRP Report No. 155 Section 6 are available from the Radiation Safety Department.

### ***9.5.1 ACCIDENT OR INJURY DURING SURGERY OR AUTOPSY***

In case of an injury occurring during surgery or autopsy whereby the gloves are cut or torn and radioactive material may have been introduced into the wound, the gloves should be removed and the wound washed with large quantities of running water, spreading the edges of the wound to facilitate flushing action. The Radiation Safety Department should be notified at once, and should check for residual contamination.

### ***9.5.2 CONTAMINATED CLOTHING OR INSTRUMENTS***

Clothing or instruments that become contaminated during surgery or autopsy should be turned over to the Radiation Safety Department for decontamination or disposal. Contaminated disposable materials should be handled as described in the section titled: "Radioactive Waste Disposal". RSD personnel can assist with this as necessary.

Special care should be taken to prevent the floor of the operating room or the autopsy room from being contaminated. Such contamination is inevitably transferred to the shoes and thereby spread all over the institution. In addition, the floors of autopsy rooms are often of rough concrete or other material that is difficult to decontaminate, and flushing them or scrubbing them with water may only spread the contamination. Therefore, great care should be taken that all body fluids are

properly discharged down the drain or given other disposal as recommended by the RSD.

In the case of accidental overflow, the fluid should immediately be taken up as completely as possible, with dry waste held in tongs or forceps, and put promptly into a suitable receptacle.



## **10. SEALED SOURCE IRRADIATORS**

### **10.1 APPLICABILITY**

This section concerns irradiators containing tens to thousands of Curies of radioactive material in sealed sources with adequate shielding as part of the design of the irradiator. Any device for which it is possible for all or part of the body to be irradiated by an unshielded source presents a much greater hazard and must be dealt with specifically on a case by case basis. For irradiators containing smaller activities, this section may serve as a model for a less extensive radiation safety program.

### **10.2 USERS**

As with any other use of radiation under our licenses, an irradiator is under the supervision of an approved Authorized User and he or she is responsible for its safe use. Other individuals may use the irradiator, but each of these must be certified in writing by the Authorized User.

To obtain certification, the individual must:

- A. Attend the general orientation to radiation safety.
- B. Receive a specific orientation on the use of the irradiator, including, but not limited to, its design, operation, safe use, including any items that should not be irradiated, and emergency procedures.
- C. Satisfactorily pass a quiz on the use of the irradiator and radiation safety considerations during its use. The U.S. Nuclear Regulatory Commission insists that familiarity with these subjects be demonstrated by passing a quiz. The Radiation Safety Department will supply the Authorized User with general radiation safety questions for this quiz and the Authorized User is responsible for the more specific questions.
- D. Observe actual or simulated operation of the irradiator. Each user will be shown the irradiator operations procedure a sufficient number of times (minimum 3) to ensure familiarity with its proper operation. This training will be provided by the Authorized User or one designated individual.
- E. Potential users of irradiators may be subject to an FBI background check. Contact the Radiation Safety Department for more information.

It is the responsibility of the Authorized User to maintain records of who has passed the quiz and received the on-the-job training and who, therefore, is certified to use the irradiator.

### **10.3 SAFETY PRECAUTIONS**

Detailed operating and emergency procedures must be available to each person who uses the irradiator. These should contain at least:

- A. Procedures for operating the irradiator
- B. Instructions concerning exposure monitoring
- C. Instructions to lock and secure the room when the room is unattended
- D. Instructions concerning what to do if abnormal radiation levels are detected, including securing the room and contacting the Radiation Safety Department
- E. Requirements and instructions for performing inspections, maintenance and tests, to ensure that all interlocks, devices and components associated with the irradiator are functioning properly.

When the irradiator is in use, there must be an operable survey meter or area monitor in the room. This should be turned on while the irradiation is in progress in the unlikely event that problems develop with the shielding or source movement.

Leak tests will be conducted every six months by the Radiation Safety Department. If the irradiator fails the leak test, it must be withdrawn from service until it is repaired or replaced.

There must be no tampering, removal, replacement or disposal of the sealed source. Repairs may be performed only by someone specifically licensed by the U.S. Nuclear Regulatory Commission.

Irradiation of explosives, corrosives, or flammables must be avoided.

### **10.4 ITEMS BEING IRRADIATED**

Irradiation with gamma rays from Cs-137 and Co-60 will not make something radioactive, so no special precautions are needed for the irradiated items after the irradiation is completed. Some items, such as explosives, corrosives and flammables may be sufficiently changed chemically by the irradiation to become more hazardous; irradiation of these items is to be avoided.

The Animal Care and Use Committee of the Institutional Review Board is concerned with the welfare of any animals being irradiated and insists that protocols for the irradiation of animals be submitted to the Committee on the Use of Radiation and Radionuclides in Animals for its approval. Only after this will the Animal Care and Use Committee consider approving the protocol.

For irradiation of other items, no specific approval of other committees is necessary once the Authorized User has obtained approval to use the irradiator.

## **11. RADIOACTIVE WASTE DISPOSAL**

### **11.1 GENERAL CONSIDERATIONS**

Proper handling, labeling and packaging of radioactive waste is essential to minimize the chance for contamination, spills or other accidents in the work area or as the waste is handled further by Radiation Safety staff. Waste drums are being more closely inspected at disposal sites as rules become more strict and disposal sites may refuse to take waste from generators that do not comply with the rules.

Because of escalating disposal costs, it is also important that only radioactive waste be disposed of in the radioactive waste containers. Minimizing the volumes generated helps to keep costs down.

The Radiation Safety office provides containers to use in the work area for radioactive waste disposal. Please call 304-293-3413 to obtain the types you need.

Radioactive waste is picked up from the work area by Radiation Safety personnel, repacked as necessary, and either held for decay or sent to commercial waste disposal centers.

Call 304-293-3413 to schedule radioactive waste pick-ups. Please do not wait until the container is overflowing! If you know a big experiment will generate a lot of waste on a particular day, please notify Radiation Safety in advance so that your lab is assured of getting a pick-up on the desired day.

No radioactive waste disposal by burial is permitted on any of the hospital or university campuses!

Always maintain accurate records of the waste disposed in each container. Radioactive waste must not be disposed of in any manner other than as outlined below.

### **11.2 TYPES OF WASTE**

For purposes of disposal, radioactive wastes will be divided into the following categories:

- A. Dry Solid Radioactive Waste
- B. Solid Biological Radioactive Waste
- C. Liquid Radioactive Waste

D. Liquid Scintillation Vials

E. Radioactive/Hazardous Mixed Waste

All categories of waste should be separated according to the half-life of the radionuclide involved.

### ***11.2.1 SHORT HALF-LIFE WASTE***

Radionuclides with half-lives of 120 days or less and Sulfur-35 are held for decay. If short half-life waste is mixed with long half-life waste the entire container must be treated as long half-life, and disposed of by a more expensive method.

If you hold waste for decay in your lab, storage area or freezer, call the Radiation Safety Department when you want to dispose of it (after 10 half-lives have passed). Radiation Safety personnel must perform the final monitoring and give approval before the waste may be disposed.

### ***11.2.2 DISPOSAL OF DRY SOLID RADIOACTIVE WASTE (NON-BIOLOGICAL)***

The general procedure is as follows:

- A. When using 5 gallon cans for solid waste, use plastic bags to line cans. Fold top of bag down over side of can. When a can is not used, pack up waste in plastic bags.
- B. Place needles and other sharp objects in puncture proof containers or sharps boxes before being put in the plastic bag.
- C. Wrap broken glassware in paper towels to prevent the plastic bag (and someone's hand) from being punctured.
- D. Place only radioactive materials in radioactive designated containers. Other materials only increase volume and raise the cost of disposal.
- E. When a bag is full, close the bag and seal the top with tape. If a can reads greater than 2 mR/hr at one meter from the can, close the plastic bag and tape up the top whether the bag is full or not. Always tape according to Bag Sealing Instructions.
- F. Transfer the closed and marked plastic bags to the shipping barrel if one is provided to the department. Complete the pertinent entries on the waste disposal record attached to the outside of the barrel or 5 gallon can.

### ***11.2.3 DISPOSAL OF SOLID BIOLOGICAL RADIOACTIVE WASTE***

Radioactive biological wastes include radioactively-contaminated animal carcasses, feces, and bedding; tissue samples; and radioactive plants. It is very important that these wastes are properly bagged. No liquid must be able to leak out.

Waste material contained inside must be prepared so that it cannot pierce the bag. This may entail padding parts of the biological waste with gauze pads or other material to keep the plastic bags from being torn and punctured.

The NRC has issued an exemption for disposal of certain animal tissues. Those containing 50 nCi per gram or less (as averaged over the weight of the entire animal) of carbon-14 or tritium may be disposed of as if they were not radioactive. Please call the Radiation Safety Department if you need assistance with this procedure. It is essential that proper records be kept of all disposals made in this manner.

### ***11.2.4 MATERIALS***

The Radiation Safety Department will provide each Authorized User or research group with Radionuclide Waste Identification Forms and yellow plastic bags for biological waste disposal. Call the Radiation Safety office when you start to run low on these items to obtain replacements.

### ***11.2.5 PROPER BAGGING***

Place radioactive biological material in YELLOW plastic bags. Make sure the material will not puncture or tear the bag. YELLOW bags are used only for radioactive material. Non-radioactive biological waste must not be placed in yellow plastic bags. Seal the bag as described in "Bag Sealing Instructions".

### ***11.2.6 DISPOSAL OF LIQUID RADIOACTIVE WASTE***

Limited disposal of liquid radioactive waste via the sanitary sewer system is permitted as described below. Short half-life liquid waste should be held separately for decay before disposal. Note that the chemicals present in some liquids may preclude their disposal via the sewer system even though the radioactive content is within allowed limits.

### ***11.2.7 LIQUID WASTE BARRELS***

Liquid waste intended for disposal into liquid waste barrels is to be separated into three categories by chemical composition of the liquid:

- A. Aqueous liquids with no organic solvents
- B. Liquid scintillation fluids
- C. Radioactive/hazardous mixed liquid waste

Heavy plastic one or five gallon containers are to be used for liquids if they are appropriate for the solvent being used.

**NOTE: IT IS EXTREMELY IMPORTANT TO USE VENTED CAPS OR LOOSE CAPS ON THE STORED WASTE. THERE HAVE BEEN EXPLOSIONS IN SEVERAL LABS BECAUSE OF PRESSURE BUILD UP.**

All of the waste containers must be labeled "Caution, Radioactive Material" and stored in an appropriate secondary, larger container to protect against leakage.

The use of glass waste containers is not recommended. If it is necessary to store waste in a glass container, place it in a secondary break-resistant container in a location where it will not be dropped or knocked over.

For pickup of waste, call the Radiation Safety office at 304-293-3413. Pick up will be as needed. Prior to pick up, fill out a radioactive materials tag (provided by the Radiation Safety Department) and attach it to the waste container. It is very important that all solvents and their percentage composition be listed on this tag.

### ***11.2.8 DISPOSAL IN THE SANITARY SEWER SYSTEM***

Soluble or readily dispersible biological material may be released into the sanitary sewerage system provided that the amount released in one month divided by the average monthly volume of water released by the institution does not exceed the concentration listed in Appendix 3.

In order to assure that this condition is met, the following procedure must be followed:

Designate a sink in the laboratory as a "Radioactive Waste Sink" and have the Radiation Safety Department mark it as such. You may use this sink for rinsing of glassware and disposal of wash water. Do not use an unmarked sink for washing contaminated glassware and disposing of wash water.

Rinse the sink with plenty of water after washing contaminated items in it. This will both reduce the contamination in the sink and further dilute the small amount of radionuclide released into the sewage system.

Store other radioactive waste liquids in closed containers with a proper label. List the contents on the label.

Call the Radiation Safety Department when you have accumulated waste to dispose. A member of the Radiation Safety staff will come to the lab to dispose of the waste or remove it to the Radiation Safety storage area.

### ***11.2.9 DISPOSAL OF LIQUID SCINTILLATION VIALS***

Liquid scintillation vials are glass or plastic vials having a capacity of 20 ml or less that are used in scintillation counting. Small amounts of tritium and carbon-14 (50 nanocuries/gram or less) are commonly employed. The NRC has issued an exemption that allows persons to dispose of vials containing these low amounts of tritium and carbon-14 as if they were not radioactive.

However, in most cases, a "cocktail" must be used to produce the scintillations that are counted. Some of these cocktails contain a solvent (such as xylene) that has to be treated as a hazardous waste when it is time for disposal. Waste disposal facilities for this type of waste are very few and disposal costs are high.

There are alternative types of liquid scintillation cocktails that contain solvents that are not considered "hazardous" for purposes of disposal. Use these cocktails whenever possible! A list of currently available cocktails is available from Radiation Safety.

Liquid scintillation vials must be packed separately from other items such as gloves, etc., but glass and plastic vials may be mixed. In addition separate vials by:

- A. Half-life (short half-life, i.e., 120 days or less and sulfur-35 vs. long half-life)
- B. Type of cocktail (hazardous vs. non-hazardous)
- C. Activity of H-3 and C-14 (50 nCi/g or less vs. greater than 50 nCi/g)

After use, store the vials in the five gallon open head pails with lever lock lids that are provided by Radiation Safety. These pails should be opened in a hood and, if feasible, stored in a hood when they contain hazardous scintillation fluids.

A record sheet is provided with each pail to record the date, radionuclides, total number of vials, total volume of fluid and total activity of the radionuclides in the pail. Call the Radiation Safety Department at 304-293-3413 for a pick up at your lab.



### **11.2.10      *RADIOACTIVE/HAZARDOUS MIXED WASTE***

There are no facilities that are authorized to take this type of waste at the present time. Therefore every effort should be made not to generate this type of waste.

If the radioactive material in the waste has a short enough half-life it can safely be held for decay. In that case, the waste will have to be disposed of as hazardous waste after the radioactivity decays away. It is essential to record the chemical composition of the waste on the label in order to be able to dispose of it properly. Extra costs involved in determining the chemical composition will be passed on to the authorized User.

### **11.2.11      *BAG SEALING DIRECTIONS***

- A. Twist the top of the bag tightly. Wrap tape tightly two or three times around the twisted section.
- B. Fold twisted section in half and wrap the tape two or three more turns.
- C. If a bag tears, then re-bag it before putting it in the waste container.
- D. Place extra bags around the original bag if necessary in order to ensure against leakage or puncture, and seal each additional bag according to the bag sealing instructions above.

### **11.2.12      *ADDITIONAL REQUIREMENTS FOR ALL RADIOACTIVE WASTE***

Only radioactive materials with an atomic number between 1 and 83 can be placed in waste barrels. All other materials with a higher atomic number such as radium (atomic no. 88), uranium (atomic no. 92), plutonium (atomic no. 94) and other source material or special nuclear material must be brought to the Radiation Safety office for separate disposal. Example: smoke detectors containing americium-241 (atomic no. 95) must have special handling.

- A. The chemical form of all waste must be specified.
- B. All waste must contain less than 1% oil by volume.
- C. Ion exchange resins and filter media must be dewatered.
- D. There must not be any detectable free standing liquids in waste barrels.

- E. No radioactive waste may contain pyrophoric materials or materials that react violently with water.
- F. The radioactive hazard must be greater than the chemical hazard. We must have an analysis of the chemical, biological, and radioactive hazard.
- G. The physical form of all waste must be specified, e.g., compressed paper, glass, etc.
- H. Biological (excluding animal carcasses), pathogenic or infectious material or equipment (e.g., syringes, test tubes, capillary tubes) used to handle such material shall be treated so that the material, if not radioactive, could have been disposed of as infectious waste.
- I. The radionuclide and activity must be specified in microcuries or millicuries. Radionuclides and activity must coincide exactly with the barrel sheet.

## 12. EMERGENCY PROCEDURES

### 12.1 INTRODUCTION

Emergencies resulting from accidents in areas working with radioactive materials can range from simple spills of small amounts of radioactive materials, where no serious contamination problem results, to major disasters occurring from explosions, fires or natural phenomena.

Correspondingly, the hazards resulting from such accidents will cover the range of situations from minor hazards to very serious situations involving extreme radiation hazards and bodily injury or both.

In view of the complicating factors that may arise during such emergencies, simple rules of procedure cannot be set down covering all situations of radiation danger. However, in any emergency the primary concern must always be the protection of personnel. Second should be the confinement of the contamination to the local area of the accident, if this is possible.

### 12.2 RESPONSE OF LABORATORY PERSONNEL

#### 12.2.1 SPILLS INVOLVING NO AIRBORNE CONTAMINATION

- A. Notify all other persons in the room at once.
- B. Monitor the skin, clothing and shoes of persons near the spill.
  - 1. If the spill is on the skin, flush thoroughly. Proceed according to "Decontamination of Personnel"
  - 2. If the spill is on clothing, discard outer or protective clothing.
- C. Block off the contaminated area. Permit only the minimum number of persons necessary to deal with the spill into the area. This prevents spread of the contamination.
- D. If the spill causes high radiation hazard (>100 millirems/hr deep-dose equivalent), vacate the room immediately, close all doors and keep everyone out until someone from the Radiation Safety Department arrives.
- E. Confine the spill.
  - 1. Put on protective gloves and lab coat. Use shoe covers if floor is contaminated.
  - 2. Drop absorbent paper on a liquid spill.
  - 3. Dampen a dry spill; take care not to spread the contamination.
  - 4. See "Decontamination of Laboratory."
- F. Perform, or have performed, any bioassays required by the RSD.

Notify the Radiation Safety Department, 304-293-3413; Radiation Safety staff will provide supervision and monitoring of the cleanup.

**DO NOT CALL THE JANITOR OR HOUSEKEEPING TO CLEAN UP RADIOACTIVE SPILLS.** The person involved is responsible for the cleanups.

### ***12.2.2 INCIDENTS INVOLVING AIRBORNE CONTAMINATION (DUSTS, MISTS, FUMES, VAPORS, GASES, AEROSOLS)***

- A. Evacuate the laboratory immediately. If time permits, hold your breath and shut off the source of contamination. (Example: If radioactive gas is leaking from a cylinder, close the cylinder valve if you can.)
- B. Shut all doors to the laboratory.
- C. Call Physical Plant or Maintenance Engineering and have the air conditioning shut down in your area.
- D. Notify Radiation Safety, 304-293-3413. Radiation Safety personnel will supervise re-entry into the contaminated area.
- E. Post a guard to ensure that no one re-enters the laboratory and to keep the area clear of spectators.
- F. Assemble and monitor all persons who were in the laboratory at the time of accident. The place of assembly should be near the contaminated area in order to reduce the spread of contamination. Proceed as in "Decontamination of Personnel".
- G. Perform, or have performed, any bioassays required by the RSD.

### ***12.2.3 INJURY TO PERSONNEL***

- A. If contamination is found in open wounds, flush the wound immediately with running water while spreading the edges of the wound.
- B. In cases where radionuclides have accidentally been released into a finger or other extremity by a needle, induce the wound to bleed by "bleeding" it as a cleansing action in addition to the running water.
- C. If contamination is found in the eyes, flush the eyes with running water.

- D. Notify RSO immediately at 304-293-3413.
- E. Perform, or have performed, any bioassays required by the RSO.
  - a. If the injury is serious, the person should be taken directly to the Emergency Room.

#### ***12.2.4 INGESTION OF RADIOACTIVE MATERIAL***

If radioactive material has been taken into the mouth, it should be assumed that some of the material has been ingested.

- A. Notify RSO immediately at 304-293-3413.
- B. If advised to do so by the RSD, induce vomiting.
- C. Take appropriate steps, as recommended by RSD, to prevent or mitigate uptake of radioactivity into tissues.
- D. Perform, or have performed, any bioassays required by the RSD.

#### ***12.2.5 FIRE***

- A. Notify all persons in immediate area.
- B. Activate nearest fire alarm signal.
- C. Call 9-911, give location of fire or smoke and any other information requested.
- D. Attempt to put out small fires if radiation hazard is not serious.
- E. Notify the Radiation Safety office, 304-293-3413 when it is safe to do so.
- F. Follow instructions given in posted Fire Emergency Plan.

### **12.3 EMERGENCY RESPONSE/SECURITY PERSONNEL**

#### ***12.3.1 EVALUATION OF RISK***

The number of places where a high amount of radiation will be present is extremely limited. The large sources of radiation, whether in the university or the hospital, are generally sealed sources. These cannot explode and they would be involved in fire only if it started elsewhere. Many laboratories use radioactive materials but almost all use small amounts. Should there be an

injured person or fire in a lab, attention should be given to these conditions first; the radioactivity will be of secondary concern.

Two places warrant more caution; both are in the hospital:

Nuclear Medicine has large amounts of radioactive materials present in forms that can be spilled or volatilized, so caution is necessary in accidents there.

Patients receiving treatments that involve actually giving them radioactive material (brachytherapy or radiopharmaceutical therapy), rather than external radiation (such as accelerator treatments) may be very radioactive.

Medical or Radiation Safety personnel should be able to assist in evaluating the risk in responding to emergencies in these areas.

### ***12.3.2 ACTIONS TO BE TAKEN IN AN EMERGENCY***

Care of the injured and response to fire should proceed without regard to radiation.

In case of grave danger or serious injury, even in instances of high radiation risk, a victim should be tended to without regard to radiation.

In any radiation emergency, make sure that the university or hospital operator has notified the Radiation Safety personnel on call.

In cases where airborne radioactive material may be present, such as in an explosion, the ventilation system may have to be shut down to prevent the spread of contamination. This may mean that self-contained breathing apparatus will need to be used by emergency response teams.

Laboratory personnel, if present, may be able to advise you if airborne material is likely to be present. If conditions permit, wait until a representative from the Radiation Safety office arrives before attempting to enter an area containing airborne radioactive material.

Secure the area. Security officers and other emergency workers should make sure that no one enters the radiation emergency area and that potentially contaminated individuals do not leave until they have been checked and cleared by Radiation Safety.

If there are seriously injured accident victims who may be contaminated by radioactive material, notify the hospital Emergency Department and have them institute their Radiation Mass Casualty Plan.

Decontamination of the injured and any emergency workers caring for them will then take place at the hospital.

Clean up and decontamination should take place under the supervision of Radiation Safety.

The Radiation Safety Department will advise concerning the need for individual monitoring devices and any follow-up actions (such as bioassays) that could be required for Emergency Response, Security, or other personnel.

## 13.DECONTAMINATION PROCEDURES

### 13.1 DECONTAMINATION OF PERSONNEL

The objective of personnel decontamination is to reduce radiation exposure promptly, minimize absorption of radionuclides through the skin, and keep localized contamination from spreading. A survey instrument is absolutely necessary.

If a person is found to have radioactive contamination on their clothing or bodies, the following steps should be taken:

#### 13.1.1 SKIN

- A. Remove any clothing found to be contaminated before determining levels of skin contamination. Generally, levels below 0.1 mrem/hr present a minimal hazard, but still should be removed if possible.
- B. Specific hot spots or areas of contamination on the skin should be located with a survey meter. (Note: Tritium cannot be detected with a survey meter. Use a wipe test to look for tritium contamination.) The hot spots should be cleaned up so as to prevent the spread of contamination to clean areas of the body.
- C. Ordinarily, soap and lukewarm water (or detergent) will remove most of the contamination.
  - 1. Wash for 1-2 minutes, rinse, and dry the areas. Pay particular attention to the hands and fingernails. Monitor with a survey meter (except for tritium). Repeat if contamination is still present.
  - 2. If contamination is still present, wash again using plenty of soap and a soft brush. Apply only light pressure to the brush. Rinse, dry and resurvey. Repeat if contamination is still present.
  - 3. Take care to keep radioactivity from being washed into any skin breaks. A sterile bandage will help.
  - 4. Even if contamination still persists, these efforts should be halted before the skin becomes reddened and irritated.
  - 5. ALWAYS contact the Radiation Safety office, 304-293-3413 for advice and final monitoring. Radiation Safety will also estimate the dose to areas where fixed contamination cannot be removed and will make appropriate notations on dose records.
- D. If contamination is widespread over the body, shower with soap and water, dry and repeat the survey. Radiation Safety will advise on how and where this should be done. If contamination is still widespread, shower with scrubbing, dry and resurvey. If contamination still exists, select the most highly contaminated areas and proceed as in C



1. and 2. above. Never let the skin become irritated.
- E. DO NOT use organic solvents. These may only increase the probability of radioactive material penetrating the skin.
- F. When decontamination is completed, apply lanolin or hand cream to prevent chapping.
- G. The Radiation Safety office should provide final monitoring and/or further requirements. The RSO will estimate the dose to any area where fixed contamination cannot be removed and make appropriate notations on dose records.

### **13.1.2 HAIR**

- A. If the hair is contaminated, try up to three washings with shampoo or liquid soap and rinse with water. Use towels to keep water from running onto the face and shoulders.
- B. The Radiation Safety Department should provide final monitoring.

### **13.1.3 CLOTHES**

- A. Contaminated clothes (or shoes) should be removed from the body to prevent further spread of the contamination. Place these items in plastic bags or containers.
- B. After necessary body decontamination has been accomplished, put on protective gloves and lab coat (or surgical gown) and rinse the clothing in a Radioactive Waste Sink (providing the sink is less contaminated than the clothing).
- C. Re-check the surface of the garments with a survey meter. (Tritium is not detectable with a survey meter.) Maximum permissible contamination is:
  1. 22 dpm/100 cm<sup>2</sup> above background for radionuclides in Group 1 of Appendix 6;
  2. 220 dpm/100 cm<sup>2</sup> above background for radionuclides in Groups 2, 3 and 4 of Appendix 6.
  3. If clothing reads less than these limits it may be released directly to the laundry.
- D. If several washings still are not able to lower the contamination then either hold it for decay if the half-life is short, or treat it as solid radioactive waste (see Section 12, "Radioactive Waste Disposal").
- E. The Radiation Safety office will provide final monitoring and advice.

## **13.2 DECONTAMINATION OF LABORATORIES**

Decontamination will be much easier if appropriate planning and precautions are made ahead of time.

- A. The general procedure is to confine the radioactive material as much as possible and prevent spread to other areas.
- B. Prepare yourself for this job by putting on protective gloves, lab coat or surgical gown, and shoe covers if the floor is contaminated.
- C. A survey instrument is a must; otherwise you are only guessing where the contamination lies. (Use a wipe test for tritium.)
- D. First remove the gross contamination caused by the spill; start at the edges of the contaminated area and work inward.
  - 1. If a large amount of gamma or high energy beta emitter has been spilled (example: a patient vomits shortly after receiving an oral therapy dose of I-131) manipulate the cleaning rags or towels with long forceps or tongs; this will significantly reduce hand exposure.
  - 2. Once a cleaning rag has become contaminated, it should be disposed of rather than reused.
- E. After removing spilled liquids or other material, soap and water or commercially available decontamination solutions should be used to remove the remainder of the contamination.
- F. All waste material should be placed in a plastic bag or other container to prevent re-contaminating the area. The waste must eventually be sealed in plastic bags as described in Section 12, "Radioactive Waste Disposal".
- G. The individual involved in the spill is responsible for the cleanup. **DO NOT CALL THE JANITOR OR HOUSEKEEPING TO CLEAN UP RADIOACTIVE SPILLS.**
- H. The Radiation Safety office will advise in the cleanup procedures and will provide final monitoring. Call 304-293-3413.

## APPENDIX 1: ORDERING, RECEIVING, OPENING, AND SHIPPING PACKAGES CONTAINING RADIOACTIVE MATERIAL

### A1.1 ORDERING

- A. Radioactive material will be ordered by an Authorized User or a qualified individual designated by the RSO (RSO).
- B. The RSO must approve or place all orders for radioactive material and ensure that the requested radioactive material(s), quantities, manufacturer and model are authorized by the license and that possession limits are not exceeded.
- C. A system for ordering and receiving radioactive material shall include the following information:
  - 1. Records that identify the Authorized User or department, radionuclide, physical and/or chemical form, activity, and supplier;
  - 2. Confirmation, through the above records, that material received was ordered through proper channels.
  - 3. For deliveries during normal working hours, inform carriers to deliver radioactive packages directly to a specified area.
  - 4. For deliveries during off-duty hours, inform security personnel or other designated persons if they should accept the delivery in accordance with Radiation Safety Precautions and provide designated persons with RSD contact information.

### A1.2 RECEIVING

Only Authorized Users or specifically identified designees are permitted to open shipping packages (shipping/transport containers) containing radioactive material. If an Authorized User, designee, or RSD representative is not available when the package is delivered, the package will be placed in a secure, pre-designated remote location of the facility awaiting such person(s). The package will not be opened. Packages containing radioactive material shall be inspected and surveyed as soon as practical after receipt of the package, but not later than three (3) hours after the package is received at the facility if it is **received during normal working hours**. Packages containing radioactive material that are **received after normal working hours** at the facility shall be inspected and surveyed not later than three (3) hours from the beginning of the next working day.

### A1.3 OPENING

- A. Put on gloves to prevent contamination. Always assume that the package and material inside are contaminated until proven otherwise.

- B. Visually inspect the package for evidence of potential contamination (crushed, wet, damaged). If damage is noted, stop the procedure and notify the RSD or other knowledgeable person.
- C. Measure the dose rate from the package at 1 meter and at the package surface. If it is higher than expected, stop and notify the RSD. The expected dose rate in mrem/hr at one meter should be close to the transportation index (T.I.) value as noted on the package [49 CFR 173.403]. The expected maximum dose rates at the surface of the package and Transportation Indices are listed below [49 CFR 172.403(c)]:

Label Type	Maximum Surface Reading (mrem/hr)	Transportation Index (mrem/hr)
White I	0.5	0
Yellow II	0.5 – 50	$0 < T.I. \leq 1.0$
Yellow III	50 – 200	$1.0 < T.I.$

\* The final delivery carrier and the NRC Operations Center (301-816-5100) or appropriate Agreement State Agency must be immediately notified by telephone [10 CFR 20.1906(d)] if external radiation levels exceed limits specified in 10 CFR 71.47.

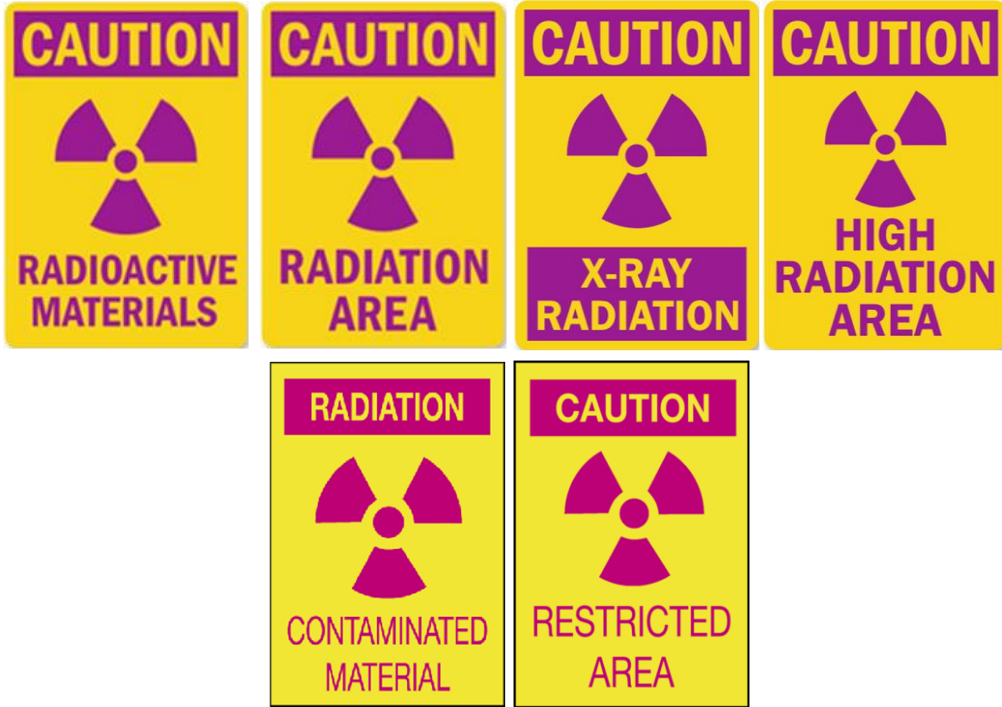
- D. Wipe at least 300 cm<sup>2</sup> of the exterior of the package and analyze the wipe. The final delivery carrier and the NRC Operations Center (301-816-5100) or appropriate Agreement State Agency must be immediately notified by telephone [10 CFR 20.1906(d)] if removable surface contamination levels exceed the limits specified in 49 CFR 173.443.
- E. Record the results of the external radiation (if applicable) and removable contamination surveys (if applicable).
- F. Remove packing slip.
- G. Open the outer package following the supplier's instructions, if provided.
- H. Open the inner package and verify that the contents agree with the packing slip.
- I. Check the integrity of the final source container if not a gas or special form material. Look for broken seals or vials, loss of liquid, condensation, or discoloration of packing material. If anything unusual is found, stop and notify the RSD. Take appropriate precautions to prevent the spread of contamination. Notify the user of the material of any contamination found.

- J. Check the user request to ensure that the material received is the material that was ordered.
- K. Monitor the packing material and empty packages for contamination with a radiation detection survey instrument prior to discarding. If it is contaminated, treat it as radioactive waste.

#### **A1.4 PREPARING PACKAGES FOR SHIPMENT**

Packages of radioactive material offered to common carriers for shipment will be prepared in accordance with applicable U.S. Department of Transportation regulations. Proper packaging, markings and labels will be used, and proper shipping papers and emergency response information will be provided with each package. Transfer records will be maintained on file for inspection purposes. Packages of radioactive material will be prepared for shipment only by personnel that have completed training specified in the U.S. Department of Transportation, Subpart H, 49 CFR Part 172.

# APPENDIX 2: RADIATION SIGNS AND SYMBOLS



**NSIC FORM 3 (10-2008)** All information may be obtained from the Radiation Safety Department, Room 3108 NSIC North, 2500 University Blvd., Morgantown, WV 26505-6000. Telephone: 304-285-5100. Fax: 304-285-5101. Website: [www.nrc.gov](http://www.nrc.gov)

**UNITED STATES NUCLEAR REGULATORY COMMISSION**  
Washington, DC 20549-0001

**NOTICE TO EMPLOYEES**  
ENFORCEMENT FOR PROTECTING AGAINST EXPOSURE FROM X-RAY, RADIATION AND RADIOACTIVE MATERIALS  
REPORTS TO WORKING SUPERVISORS ABOUT THE RESPONSIBILITY PROGRAM

**WHAT IS THE RESPONSIBILITY PROGRAM?**  
The Radiation Health Program (RHP) is a regulatory program that is designed to protect workers and the public from unnecessary exposure to ionizing radiation. The purpose of the RHP is to provide enough information to workers so that they can make informed decisions about their work and the use of radiation materials which is not provided as a byproduct of nuclear energy.

**WHAT IS THE RESPONSIBILITY OF MY EMPLOYER?**  
The NRC Code of State Regulations, Title 54 Chapter 23, requires that employers must ensure that all employees and both in the Radiation Health Program (RHP) and in the State of West Virginia are provided with the information necessary to make informed decisions about their work and the use of radiation materials which is not provided as a byproduct of nuclear energy.

**WHAT IS MY RESPONSIBILITY?**  
It is your responsibility to report to your supervisor if you are exposed to radiation or if you observe a violation of the RHP. You should also report any safety concerns you observe in your work area.

**UNITED STATES NUCLEAR REGULATORY COMMISSION**  
Washington, DC 20549-0001

**NOTICE TO EMPLOYEES**

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**WHAT IF I CAUSE A VIOLATION?**  
If you intentionally violate the RHP, you may be subject to enforcement action. If you report such a violation, the RHP will consider the circumstances surrounding your reporting in the determination of appropriate enforcement action.

**HOW MUCH RADIATION AM I ALLOWED TO GET?**  
If you work with a radioactive substance in a source of ionizing radiation, the amount of radiation you are allowed to receive is limited by the RHP. The RHP sets limits on the amount of radiation you are allowed to receive in sections 54.23.1-1, 54.23.1-2, 54.23.1-3, 54.23.1-4, 54.23.1-5, 54.23.1-6, 54.23.1-7, 54.23.1-8, 54.23.1-9, 54.23.1-10, 54.23.1-11, 54.23.1-12, 54.23.1-13, 54.23.1-14, 54.23.1-15, 54.23.1-16, 54.23.1-17, 54.23.1-18, 54.23.1-19, 54.23.1-20, 54.23.1-21, 54.23.1-22, 54.23.1-23, 54.23.1-24, 54.23.1-25, 54.23.1-26, 54.23.1-27, 54.23.1-28, 54.23.1-29, 54.23.1-30, 54.23.1-31, 54.23.1-32, 54.23.1-33, 54.23.1-34, 54.23.1-35, 54.23.1-36, 54.23.1-37, 54.23.1-38, 54.23.1-39, 54.23.1-40, 54.23.1-41, 54.23.1-42, 54.23.1-43, 54.23.1-44, 54.23.1-45, 54.23.1-46, 54.23.1-47, 54.23.1-48, 54.23.1-49, 54.23.1-50, 54.23.1-51, 54.23.1-52, 54.23.1-53, 54.23.1-54, 54.23.1-55, 54.23.1-56, 54.23.1-57, 54.23.1-58, 54.23.1-59, 54.23.1-60, 54.23.1-61, 54.23.1-62, 54.23.1-63, 54.23.1-64, 54.23.1-65, 54.23.1-66, 54.23.1-67, 54.23.1-68, 54.23.1-69, 54.23.1-70, 54.23.1-71, 54.23.1-72, 54.23.1-73, 54.23.1-74, 54.23.1-75, 54.23.1-76, 54.23.1-77, 54.23.1-78, 54.23.1-79, 54.23.1-80, 54.23.1-81, 54.23.1-82, 54.23.1-83, 54.23.1-84, 54.23.1-85, 54.23.1-86, 54.23.1-87, 54.23.1-88, 54.23.1-89, 54.23.1-90, 54.23.1-91, 54.23.1-92, 54.23.1-93, 54.23.1-94, 54.23.1-95, 54.23.1-96, 54.23.1-97, 54.23.1-98, 54.23.1-99, 54.23.1-100.

**WHAT IS THE RESPONSIBILITY OF MY EMPLOYER?**  
The NRC Code of State Regulations, Title 54 Chapter 23, requires that employers must ensure that all employees and both in the Radiation Health Program (RHP) and in the State of West Virginia are provided with the information necessary to make informed decisions about their work and the use of radiation materials which is not provided as a byproduct of nuclear energy.

**WHAT IS MY RESPONSIBILITY?**  
It is your responsibility to report to your supervisor if you are exposed to radiation or if you observe a violation of the RHP. You should also report any safety concerns you observe in your work area.

**REPORTS TO WORKING SUPERVISORS ABOUT THE RESPONSIBILITY PROGRAM**

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### APPENDIX 3: QUANTITIES OF LICENSED MATERIAL REQUIRING LABELING <sup>A, B</sup>

Radionuclide	Abbreviation	Quantity (μCi)
Hydrogen-3	H-3	1,000
Carbon-14	C-14	1,000
Fluorine-18	F-18	1,000
Sodium-22	Na-22	10
Sodium-24	Na-24	100
Phosphorus-32	P-32	10
Phosphorus-33	P-33	100
Sulfur-35	S-35	100
Calcium-45	Ca-45	100
Chromium-51	Cr-51	1,000
Cobalt-57	Co-57	100
Cobalt-60	Co-60	1
Nickel-63	Ni-63	100
Gallium-67	Ga-67	1,000
Gallium-68	Ga-68	1,000
Germanium-68	Ge-68	10
Strontium-89	Sr-89	10
Molybdenum-99	Mo-99	100
Technium-99m	Tc-99m	1,000
Indium-111	In-111	100
Iodine-123	I-123	100
Iodine-125	I-125	1
Iodine-129	I-129	1
Iodine-131	I-131	1
Xenon-133	Xe-133	1,000
Cesium-137	Cs-137	10
Barium-133	Ba-133	100
Gold-198	Au-198	100
Thallium-201	Tl-201	1,000
Rubidium-86	Rb-86	100
Radon-222	Rn-222	1
Radium-226	Ra-226	0.1
Uranium-235	U-235	0.001
Uranium-238	U-238	100
Americium-241	Am-241	0.001

- a. Each container in which radioactive material is transported, used or stored in amounts greater than the quantity specified above require labeling.
- b. Each area of the laboratory in which radioactive materials are used or stored in an amount exceeding 10 times the quantity of radioactive material specified above require labeling.

For a complete listing of nuclides refer to 10 CFR 20 Appendix C

## **APPENDIX 4: GUIDELINES FOR NURSING PERSONNEL FOR PROCEDURES OF CONCERN**

### **A4.1 RADIOGRAPHIC/FLUOROSCOPIC PROCEDURES**

- A. A radiation monitoring dosimeter (badge) should always be worn when working with radiographic/fluoroscopic equipment or in radiographic/fluoroscopic procedures. The badges worn should be those issued for the current time period and should be worn at the collar for those workers who wear only one badge. For those workers who have been issued two badges, one should be worn at the collar and the other at the waist under the lead apron.
- B. Remain in room during radiographic/fluoroscopic procedures only if necessary. Less time spent around a radiation source means a lower radiation exposure to the individual. Remember: The main source of exposure is radiation scattered from the patient.
- C. If you must remain in the room during these procedures, you must wear a lead apron of at least 0.25 mm lead equivalence. Note: A lead apron of 0.25 mm lead equivalence will reduce scattered X-rays by 95%.
- D. If it is necessary to restrain a patient during an X-ray exam, mechanical restraining devices should be used whenever possible. If a patient must be held in place by an individual for an X-ray exam, that individual shall be protected by a whole body apron of at least 0.25 mm lead equivalence. Any part of the individual's body in the X-ray beam during the exposure must be protected by at least 0.5 mm lead equivalence.
- E. Since radiation decreases rapidly with distance, the further one is from the patient during the actual X-ray examination, the smaller your exposure. Maintain the maximum distance possible from the patient during radiography and fluoroscopy.

### **A4.2 I-131 THERAPY PATIENTS**

I-131 is used to treat patients with thyroid carcinoma or hyperthyroidism. I-131 is generally administered orally in a liquid, capsule, or caplet form. Major therapies are procedures involving 33 millicuries (mCi) or more. Any patient receiving major therapies may be admitted to the hospital as determined by patient-specific dose calculations. If calculations demonstrate the potential total effective dose equivalent to any individual would be greater than 500 millirem, the patient shall remain hospitalized until the activity is less than 33 mCi, the measured dose rate at one meter from the patient is less than 7 millirem per hour, or patient-specific calculation demonstrates that the potential total effective dose to any individual would not be greater than



500 millirem. Radiation **exposure and contamination** are both concerns when working with I-131 patients. The following guidelines should be observed when working with I-131 patients:

- A. I-131 therapeutic, in-patient procedures may only be performed in single occupancy, corner rooms and are NOT allowed visitors during their stay.
- B. Caregivers requiring access to the patient room will be provided radiation monitoring dosimeters (badges). Always wear your badge when attending the patient. Wear the badge between your waist and collar and make sure that the badge worn is the one issued in your name for the current monitoring period. Do not share badges with other workers. When you are not working, store your badge in a controlled area away from all radiation sources.
- C. Provide all necessary care, but:
  - 1. Try to minimize time spent with the patient
  - 2. Work no closer to the patient than is necessary
  - 3. Wear disposable gloves, gowns, and booties when attending the patient.
- D. Carefully note instructions posted with the “Caution Radiation” sign and any radiation safety instructions written in the patient’s chart.
- E. Housekeeping and Dietary staff are NOT permitted in I-131 patient rooms. I-131 patients are to be provided with isolation food trays.
- F. Do not remove room items without clearance from the Radiation Safety Department.
- G. The Radiation Safety Department will survey the patient daily and will notify personnel when activity contained in the patient is below release criteria.

Notify Radiation Safety (Office: 304-293-3413, Pager: 304-987-1586) if there is a spill of patient urine, the patient vomits, or if there is a medical emergency (including patient death).

#### **A4.3 PROSTATE SEED IMPLANT BRACHYTHERAPY PATIENTS**

Prostate brachytherapy is a minimally invasive procedure that implants small radioactive pellets (called seeds) that are about the size of a grain of rice into the prostate where they emit very low energy radiation, which is primarily absorbed in the treatment area immediately surrounding the seeds. Needles containing the seeds are inserted through the skin of the perineum. The radioactive material within the seeds gives off localized radiation for a number of months. Typically 50-100 seeds containing I-125 are permanently implanted.

These patients usually are administered an amount of radioactive material that is below regulatory release limits, and under normal conditions, patients can go home. For certain reasons, these patients may be hospitalized in a private room. No specific room is required for prostate brachytherapy treatments and patients are allowed visitors. The following guidelines should be observed:

- A. The use of personnel monitoring badges is not necessary when attending these patients. Radiation exposure is very low.
- B. Provide all necessary care, but try to minimize time spent with patient, and work no closer to patient than necessary.
- C. Primary hazard: Some seeds may be lost through urination. If the patient does not have a urinary catheter in place, any seed(s) that are lost through urination can be flushed. If a patient does have a catheter and catheter bag in place, the bag should be visually inspected for seeds. If a seed is found do not attempt to remove the seed. Immediately notify the Radiation Safety Department for disposal.
- D. No room items are to be removed without clearance from Radiation Safety. It is especially important to hold the catheter and bag for survey.

Notify Radiation Safety (Office: 304-293-3413, Pager: 304-987-1586) if there is a medical emergency (including patient death).

If a source becomes dislodged from the patient:

- E. Do NOT touch the source! If possible, use a broom or some long handling tool to move it to a room corner.
- F. Remove all unnecessary personnel from source area and call Radiation Safety.
- G. Do not leave source near patient or attempt to re-insert source in patient.

## APPENDIX 5: RADIATION SAFETY FORMS AND GUIDELINES

Form #	Form Name:	Date Last Revised
6	Declared Pregnant Worker Monthly Reporting Memo	4/19/2005
501	Declaration of Pregnancy Form	4/25/2005
502	Regulation 8.13 Instruction Prenatal Radiation Exposure	4/25/2005
503	Pregnant Radiation Worker Info Sheet	4/25/2005
601	Human Use Application	4/28/2005
602	Non-Human Use Application	4/28/2005
697	Survey Meter Borrowing Registration Form	4/25/2005
698	Survey Meter Pickup and Return Record Form	4/25/2005
699	Survey Meter Registration Form	3/16/2005
708	Internal Transfer of RAM	4/19/2005
722	Analytical X-Ray Equipment Service/Repair/Alteration Request Form	4/11/2005
724	RSD Radiation Producing Device Registration Form	4/11/2005
740	Radioisotope Transfer Request Form	3/16/2005
800	Lab Worker Registration Form	4/28/2005
801	Radiation Monitoring Policy Statement	4/28/2005
804	Badge Application Form	4/28/2005
824	Waste Composition Record (30-50 gal)	3/16/2005
825	Waste Composition Record (5 gal)	3/16/2005
826	RSD Waste Removal Request Form	3/16/2005
827	Liquid Waste Disposal Form	4/28/2005
828	Uranyl Acetate/ Nitrates" Waste Disposal Form	4/28/2005

Electronic copies of forms can be found on the RSD website: <http://www.hsc.wvu.edu/rsafety/>

**APPENDIX 6: CLASSIFICATION OF ISOTOPES ACCORDING TO  
RELATIVE RADIOTOXICITY PER UNIT ACTIVITY**

<b>Radiotoxicity Group</b>	<b>Radioisotopes</b>
<i>Very High (group 1)</i>	Pb-210, Po-210, Ra-223, Ra-226, Ra-228, Ac-227, Th-227, Th-228, Th-230, Pa-231, U-230, U-232, U-233, U-234, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Am-243, Cm-242, Cm-243, Cm-244, Cm-245, Cm-246, Cf-249, Cf-250, Cf-252
<i>High (group 2)</i>	Na-22, Cl-36, Ca-45, Sc-46, Mn-54, Co-56, Co-60, Sr-89, Sr-90, Y-91, Zr-95, Ru-106, Ag-110m, Cd-115m, In-114m, Sb-124, Sb-125, Te-127m, Te-129m, I-124, I-125, I-126, I-131, Cs-134, Cs-137, Ba-140, Ce-144, Eu-152, Eu-154, Tb-160, Tm-170, Hf-181, Ta-182, Ir-192, Tl-204, Bi-207, Bi-210, At-211, Pb-212, Ra-224, Ac-228, Pa-230, Th-234, U-236, Bk-249
<i>Moderate (group 3)</i>	Be-7, C-14, F-18, Na-24, Cl-38, Si-31, P-32, P-33, S-35, Ar-41, K-42, K-43, Ca-47, Sc-47, Sc-48, V-48, Cr-51, Mn-52, Mn-56, Fe-52, Fe-55, Fe-59, Co-57, Co-58, Ni-63, Ni-65, Cu-64, Zn-65, Zn-69m, Ga-72, As-73, As-74, As-76, As-77, Se-75, Br-82, Kr-85m, Kr-87, Rb-86, Sr-85, Sr-91, Y-90, Y-92, Y-93, Zr-97, Nb-93m, Nb-95, Mo-99, Tc-96, Tc-97m, Tc-97, Tc-99, Ru-97, Ru-103, Ru-105, Rh-105, Pd-103, Pd-109, Ag-105, Ag-111, Cd-109, Cd-115, In-115m, Sn-113, Sn-125, Sb-122, Te-125m, Te-127, Te-129, Te-131m, Te-132, I-130, I-132, I-133, I-134, I-135, Xe-135, Cs-131, Cs-136, Ba-131, La-140, Ce-141, Ce-143, Pr-142, Pr-143, Nd-147, Nd-149, Pm-147, Pm-149, Sm-151, Sm-153, Eu-152, Eu-155, Gd-153, Gd-159, Dy-165, Dy-166, Ho-166, Er-169, Er-171 (9.2 hr), Tm-171, Yb-175, Lu-177, W-181, W-185, W-187, Re-183, Re-186, Re-188, Os-185, Os-191, Os-193, Ir-190, Ir-194, Pt-191, Pt-193, Pt-197, Au-196, Au-198, Au-199, Hg-197, Hg-197m, Hg-203, Tl-200, Tl-201, Tl-202, Pb-203, Bi-206, Bi-212, Rn-220, Rn-222, Th-231, Pa-233, Np-239
<i>Low (group 4)</i>	H-3, O-15, Ar-37, Co-58m, Ni-59, Zn-69, Ge-71, Kr-85, Sr-85m, Rb-87, Y-91m, Zr-93, Nb-97, Tc-96m, Tc-99m, Rh-103m, In-113m, I-129, Xe-131m, Xe-133, Cs-134m, Cs-135, Sm-147, Re-187, Os-191m, Pt-193m, Pt-197m, Th-232, Th-Nat, U-235, U-238, U-Nat

**IN CASE OF A RADIATION EMERGENCY**

DURING NORMAL WORKING HOURS:  
(Monday through Friday 8:15 am – 4:45 pm)

Call the RSO at  
**(304) 293-3413**

OUTSIDE NORMAL WORKING HOURS:

Page the on call Radiation Safety Specialist at  
**(304) 987-1586**

**Radiation Safety Department**

Health Sciences Center – North, Room G-139

P.O. Box 9006

Morgantown, WV 26506-9006

Office Phone: (304) 293-3413

Fax: (304) 293-4529

<http://www.hsc.wvu.edu/rsafety/>