STATEMENT OF AUTHORITY

Upon publication of these procedures, the Radiation Safety Committee of the Augusta Veterans Administration Medical Center (AVAMC) is hereby authorized to act as agent in matters of review, control, and mediation arising from the use or proposed use of radioactive materials and/or other sources of ionizing radiation.

Don Burnette — 10-20-1986

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# I. RESPONSIBILITIES

## A. RADIATION SAFETY COMMITTEE

### 1. RESPONSIBILITIES

The Committee is responsible for:

a. Ensuring that all individuals who work with or in the vicinity of radiation and/or radioactive material have sufficient training and experience to enable them to perform their duties safely and in accordance with Nuclear Regulatory Commission (NRC) regulations, the conditions of the NRC license, and this guide.

b. Ensuring that use of radiation and/or radioactive material is conducted in a safe manner and in accordance with NRC regulations, the conditions of the NRC license, and this guide.

c. Participating in and helping to administer the institutional program to maintain radiation exposures as low as reasonably achievable (ALARA).

### 2. DUTIES

The committee shall:

a. Be familiar with pertinent NRC regulations, the terms of the NRC license, information submitted in support of the request for the NRC license and its amendments, and this guide.

b. Establish a program to ensure that individuals whose duties may require them to work in the vicinity of radiation and/or radioactive material (e.g., Nuclear Medicine Service personnel, Nursing, Security and Housekeeping personnel) are properly instructed.

c. Review and approve requests for use of radiation and/or radioactive material within the institution.

d. Prescribe special conditions that will be required during a proposed use of radioactive material such as possession limits, requirements for bioassays, physical examinations of users and special monitoring procedures.

e. Review the entire radiation safety program at least annually to determine that all activities are being conducted safely and in accordance with NRC regulations, the conditions of the license, and this guide. The review shall include an examination of occupational radiation exposure records, reports from the radiation safety officer, results of NRC inspections and written safety procedures.

f. Recommend remedial action to correct any deficiencies (i.e., high exposures, excessive or frequent laboratory contamination, etc.) identified in the radiation safety program.

g. Maintain written records of committee meetings, actions, recommendations, and decisions.

h. Ensure that the NRC license is amended, when necessary.

3. MEETING FREQUENCY

The RSC shall meet as often as necessary to conduct its business, but not less often than once in each calendar quarter.

4. COMMITTEE MEMBERSHIP

The following individuals or their selected representatives shall be appointed by the Director, AVAMC to serve as members of the committee:

a. Chief, Nuclear Medicine Service (Chairperson)
b. Chief, Laboratory Service
c. Chief, Nursing Service
d. Radiation Safety Officer
e. AA/ACOS for Research
f. Chief of Staff

The Committee membership should also include additional persons such as the following or their selected representatives:

a. Acting Assistant Chief, Nuclear Medicine Service
b. Basic scientists
c. Chief, Radiology Service
d. Chief, Engineering Service

## 5. REQUIREMENTS FOR TRAINING AND EXPERIENCE

The use of byproduct (i.e., nuclear reactor produced) radioactive material at the AVAMC is licensed by the U.S. Nuclear Regulatory Commission (NRC). The Radiation Safety Committee (RSC) evaluates the training, experience and proposed experimentation of an applicant and will approve or disapprove the applicant to use radioactive materials. The approval may be conditional (subject to PI attending a course, gaining experience under someone else's supervision for a certain length of time, etc.). Although not licensed by the NRC, the use of radiation producing machines and the use of accelerator produced or naturally occurring radioactive materials are regulated by the RSC. The use of these sources of radiation must be in compliance with appropriate governmental regulations. Training and experience of investigators using these sources of radiation are evaluated by the RSC.

## B. RADIATION SAFETY OFFICER

### 1. RESPONSIBILITIES

The Radiation Safety Officer (RSO) is responsible for ensuring that activities at AVAMC involving the use of radiation sources are carried out in a safe manner and in compliance with NRC regulations, the conditions of the AVAMC-NRC license, and procedures set forth by the Radiation Safety Committee.

### 2. DUTIES

The RSO shall:

a. Make personnel monitoring equipment available to appropriate personnel.

b. Direct routine inspection of laboratories using or storing radioactive materials.

c. Review the qualifications of individuals, evaluate their proposed uses of radiation sources and make appropriate recommendations to the RSC.

d. Ensure that all laboratories have appropriate warning signs, work areas, disposal supplies and secure storage areas for radioactive materials.

e. Participate in the administration of therapeutic doses of radiopharmaceuticals. This involves (as appropriate) making radiation level measurements, instructing nurses and patients and their relatives, making arrangements for disposal of waste, and decontamination.

## C. PRINCIPAL INVESTIGATOR

### 1. RESEARCH USES OF RADIOACTIVE MATERIALS

The principal investigator (PI) is responsible to see that the use of radioactive materials under his authorization complies with all governmental regulations, the specific conditions and limitations of his authorization, and the procedures and practices of the AVAMC. He must ascertain that all persons who use radioactive materials under the coverage of his authorization are supervised, properly trained and experienced, aware of the attendant radiation hazard, and observe the procedures of this guide.

The PI is responsible to maintain a safe working environment and to keep exposures as low as reasonably achievable (ALARA). This includes performing or having lab personnel perform lab surveys at appropriate frequencies and having lab personnel wear monitoring badges and/or undergo bioassay measurements when necessary. Any spill, suspected overexposure, theft or loss of material, or other accident must be reported to the Radiation Safety Office immediately. All lab workers must attend the short course offered by the Radiation Safety Office on radiation protection principles.

The PI is responsible for maintaining inventory records of radioactive material ordered, received, used and disposed of under his/her authorization. He/she must also submit a new application for any project significantly different from those previously approved by the committee even if the same radionuclides are to be used (for instance for studies involving animals when previous approvals were given only for in vitro use).

Upon termination of employment, the PI shall contact the Radiation Safety Office prior to leaving and shall account for and dispose of all radioactive materials on his/her inventory.

### 2. X-RAY PRODUCING MACHINES

The principal investigator (PI) or physician must assure that all users of an x-ray machine are adequately trained in its proper use and are cognizant of the hazards and safety precautions involved in their work. The PI is also responsible to have individuals wear monitoring badges when necessary.

The Radiation Safety Office should be notified immediately in the following circumstances:

a. when an overexposure to radiation is indicated or suspected

b. upon failure of an interlock or "fail-safe" device

c. when change in experimental design could result in significant hazard

d. before shielding is changed or the machine is relocated

e. for other situations which the user believes could result in a hazard

f. for a recalibration of output whenever the x-ray tube, high-voltage rectifier, or any other major component is replaced

g. before the x-ray machine is moved or disposed of or before the responsibility for its safety or use is transferred to another person.

## 3. ROUTINE MEDICAL USES OF RADIOACTIVE MATERIALS

Physicians who use radioactive materials for routine diagnostic or therapeutic procedures must have adequate training and experience as defined by the NRC. The Radiation Safety Office should be contacted for the specific requirements and forms that must be completed. In this manual, the term "Principal Investigator" refers also to such physicians where appropriate.

## D. USER OF RADIOACTIVE MATERIALS

Each individual user of radioactive materials is responsible for their safe use in order to minimize the exposure not only to himself but to others as well. A knowledge of laboratory procedures (Chapter VI), waste disposal procedures (Chapter VII) and emergency procedures (Chapter II) is, therefore, necessary. A short course on radiation protection principles is offered by the Radiation Safety Office and must be attended by all lab workers as soon as possible after they begin work in a radioisotope lab.

Each user of radioactive materials is responsible for the proper wearing and care of his/her radiation badge (if issued) and for having bioassay measurements performed when necessary.

## E. USER OF RADIATION PRODUCING MACHINES

Each user of radiation producing machines is responsible for their safe use in order to minimize the exposure to himself, other employees and patients. A knowledge of proper techniques for operation x-ray machines (Chapter VIII) is, therefore, necessary.

Each user of radiation producing machines is responsible for the proper wearing and care of his/her radiation badge and protective clothing (lead apron, gloves, etc.).

The installation and use of all x-ray equipment must comply with regulations of the VAMC and JCAH. All such equipment must be surveyed by Medical Physics at least once each year and after any modifications or servicing that may affect the operation or output of the machine.

# II. EMERGENCIES

## A. SPILLS

The person or project group responsible for a spill is also responsible for decontamination. DO NOT CALL HOUSEKEEPING TO CLEAN UP RADIOACTIVE SPILLS. It is a responsibility of all individuals who work with radioactive materials to have a basic understanding of decontamination principles and to be aware of their responsibilities in the event of an emergency.

1. Minor Spills

   a. NOTIFY persons in area that a spill has occurred.

   b. PREVENT SPREAD of spill

      i. Drop absorbent paper on a wet spill.

      ii. Place moist absorbent paper on a dry spill, taking care not to spread the contamination.

      iii. CLEAN UP:Use disposable gloves and remote handling tongs. Carefully insert the absorbent paper into a plastic bag and dispose of into the radioactive waste container.Also insert into the plastic bag all other contaminated materials such as disposable gloves.

      iv. SURVEY skin, clothing and area around spill with survey meter or wipes.

      v. REPORT the incident to the Radiation Safety Office.

2. Major Spills

   a. NOTIFY all persons not involved in the spill to vacate the room. Keep persons who may be contaminated from leaving the area until surveyed.

   b. PREVENT SPREAD of spill.

      i. Drop absorbent paper on a wet spill.

      ii. Place moist absorbent paper on a dry spill, taking care not to spread the contamination.

      iii. Do not attempt to clean up spill.

iv. Block off the contaminated area. Do not allow unauthorized persons to enter.

v. Confine the movement of all personnel potentially contaminated to prevent the spread.

vi. If contamination is airborne, close windows and doors and evacuate laboratory. Call Radiation Safety immediately.

c. SHIELD THE SOURCE: If possible, the spill should be shielded, but only if it can be done without further contamination or without significantly increasing your radiation exposure.

d. NOTIFY RADIATION SAFETY. The Radiation Safety Officer will provide supervision and monitoring of the cleanup.

e. PERSONNEL DECONTAMINATION: Contaminated clothing should be removed and stored for further evaluation by the Radiation Safety Officer. If spill is on the skin, flush thoroughly and then wash with mild soap and water (see decontamination procedures in the following section).

## B. DECONTAMINATION OF PERSONNEL

### 1. Surface Contamination

PROMPT REMOVAL of surface contamination is necessary to prevent possible transfer of the radioactive material to internal organs by absorption through the skin, ingestion or through cuts, and also to prevent possible radiation overexposure to the skin.

Records should be kept of initial exposure rates of contaminated areas, methods of decontamination used, and subsequent exposure rates after each attempt of removing the contamination.

Rule of Thumb for beta particles:The surface dose rate through the nominal protective layer of skin (7 mg/sq.cm.) from a uniform thin deposition of 1 μCi/sq.cm. is about 9 rads/hour for energies above about 0.6 MeV.Note that in a thin layer, the beta dose rate exceeds the gamma dose rate, for equal energies released, by about a factor of 100.

External contamination tends to adhere to human skin, particularly in folds or crevices, and should be monitored with a survey meter or by smear tests. Specific hot areas so located should be cleaned up first to prevent the spread of contamination to clean areas of the body.

Decontamination of body surfaces may be carried out by washing the affected area with mild soap or detergent and water, or a commercial skin decontaminating agent may be used. Wash 2-3 minutes and then monitor. Repeat if necessary.Do not wash more than 3 or 4 times as continued washing will abrade the skin. A soft brush may be used to lightly scrub the area, but care must be taken not to allow the skin to become irritated or abraded. In no case should decontamination continue to the point where the effectiveness of the skin as a protective barrier is destroyed. Other techniques which may be used to decontaminate skin in certain circumstances are as follows:

a. Water (not hot or very cold), soft brush
b. Mild soap
c. 50% tide, 50% cornmeal mixture in water
d. mildly abrasive soap (LAVA)
e. 5% mixture (in water) of 30% tide, 65% calgon, 5% carboxyl-methyl cellulose
f. plastic bag over arm or leg for several hours to cause perspiration
g. tape applied to and removed from contaminated area
h. sawdust and water
i. sandpaper
j. clorox (undiluted for small area, diluted in water for large area)

If a suitable solvent for the material is known, which is not injurious to the skin, this may be tried also. Do not use organic solvents, as these may only increase the probability of radioactive material penetrating the skin.

2. Cuts

Individuals who are cut by glassware or whose skin is punctured by a hypodermic needle should induce the wound to bleed and should wash the wound under running water.

3. Ingestion

Persons swallowing radioactive material should be treated as for poisoning. Vomiting should be induced or a stomach pump should be used to remove the ingested material.

4. Reports

REPORT all radiation incidents involving intake or contamination of personnel to Radiation Safety.

## C. DECONTAMINATION OF LABORATORIES AND EQUIPMENT

1. MONITOR to determine level and location of contamination.

2. CONFINE the contamination as much as possible. Mark off contaminated areas, for example, by using masking tape. Take care not to track contamination out of a contaminated area; monitor persons leaving the area, especially hands and shoes. If labware is contaminated, label it with warning tape if it is not going to be immediately decontaminated.

3. Wear PROTECTIVE CLOTHING such as lab coat, rubber gloves, and shoe covers if floor is contaminated.

4. CLEANING SPILLS: First remove hot spots, then work from the perimeter toward the center. Do not use excessive water as this may allow the contamination to run off. If a large amount of gamma or high energy beta emitter has been spilled manipulate the cleaning rags with forceps or tongs. If contamination levels cannot be sufficiently reduced, the surface should be stripped or covered.

5. DRY SPILLS should be removed by wet methods, using wet absorbent paper to prevent dispersion. This will reduce the inhalation hazard.

6. DECONTAMINATION OF EQUIPMENT can usually be accomplished by using conventional cleaning methods. Plasticware is very difficult to decontaminate; if the item is inexpensive it may be simpler to dispose of such equipment.

7. DECONTAMINATION AGENTS. Soap or detergent and water are generally sufficient. Commercial decontamination agents are readily available and generally effective. Solutions of sodium thiosulfate should be maintained if the laboratory uses radioiodine. Many other chemical and physical agents may be used for severely contaminated surfaces; consult with the Radiation Safety Office for details.

8. Isolate rags, brushes, etc., used in cleanup until they can be monitored. DISPOSE of contaminated waste material properly.

9. Areas and items should be decontaminated to below the following limits:

| TOXICITY CLASS OF RADIOISOTOPE | ACTION LEVEL FOR DECONTAMINATION |
|---|---|
| High and Very High | 220 dpm per 100 sq.cm. area |
| Slight and Moderate | 2200 dpm per 100 sq.cm. area |

10. Suggested items for a radioactivity decontamination kit:

a. Radiation signs and warning tape.
b. Disposable gloves.
c. Small plastic bags or shoe covers.
d. Masking tape or grease pencil.
e. Soft scrub brush.
f. Large plastic bag for waste.
g. Forceps or tongs.
h. Small paper bags for sharp & broken objects.
i. Gauze sponges and/or paper towels.
j. Large absorbent pads.
k. Detergent/emulsifier.
l. Scouring powder.
m. Tags for waste.
n. Filter paper for wipes.
o. Paper bag or other container to hold all these items.

# III. RADIATION MONITORING

## A. MAXIMUM PERMISSIBLE DOSES AND DOSE RATES

| Occupational Exposure | MPD |
|---|---|
| Whole body, head & trunk, active blood-forming organs, lens of eye, gonads | 1.25 rem/quarter |
| Hands and forearms, feet and ankles | 18.75 rem/quarter |
| Skin of whole body | 7.5 rem/quarter |
| Thyroid | 30 rem/yr |
| Other organs | 15 rem/yr |
| Whole body (if total dose is less than 5(N-18) and Form RHS-1 compiled) | 3 rem/quarter |
| Individuals \out60\ 18 years old | 10% of above limits |
| Fetus (from occupational exposure to mother) | 0.5 rem/gestation period |

| Population Dose Limits | Dose Rate |
|---|---|
| Average population dose (excluding natural background and medical). | 0.17 rem/year |
| Individual member of public (excluding natural background and medical). | 0.5 rem/year |

| Area Classification | Dose Rate |
|---|---|
| Unrestricted Area | ( 2 mrem in any one hour or<br>( 100 mrem in any 7 consecutive days |
| Radiation Area | ) 5 mrem in any one hour or<br>) 100 mrem in any 5 consecutive days |
| High Radiation Area | ) 100 mrem in any one hour |

## B. ALARA POLICY

The V. A. Medical Center, Augusta, GA is committed to maintain radiation exposures to employees, patients, visitors and the general public from activities conducted at the institutior as low as reasonably achievable (ALARA). This is accomplished by enforcing the policies stated elsewhere in this manual such as requirements of investigators using radiation sources in research and surveys of patients undergoing radiotherapy treatments as well as an extensive survey and quality control program for x-ray machines.

Radiation monitoring reports are reviewed monthly by the Radiation Safety Officer or other qualified person. A list of individuals receiving quarterly exposures in excess of 10% the limits given in section A. of this chapter is compiled. In some departments, such as Radiology, it is not unusual for exposures to exceed this level, however for departments where it is unexpectedly hign and for all exposures in excess of 30% of the MPD, an investigation will be conducted to determine the cause and suggest methods for changing work habits if possible.

## C. PERSONNEL MONITORING

Individuals who may receive an occupational radiation exposure in excess of 25% of the MPD given in Section A of this chapter must wear a radiation monitoring device. These are furnished by an outside vendor through the Radiation Safety Office. All such individuals, and any other persons who work with radiation sources who wish to be monitored, should fill out a badge application form at the Radiation Safety Office. The badges are not sensitive to low energy beta radiation such as emitted by H-3 and C-14. It is, therefore, not necessary for individuals working only with these radionuclides to wear a badge.

It is the responsibility of the principal investigator to ensure that all persons who use radionuclides or work in an area where radionuclides are used wear appropriate radiation dosimeters when required.

Personnel exposure records are maintained by the Radiation Safety Office. Copies of monthly exposure reports are provided to appropriate departments for posting.

Pocket ionization chamber dosimeters are available from the Radiation Safety Office to be used by individuals who are or may be working in high radiation areas for immediate exposure information. They are not acceptable as a legal record and must therefore be used along with a film or TLD badge. Care must be taken in using these dosimeters since readings may be inaccurate when used over time periods greater than a few days. They must be compared against a similar dosimeter kept in a low background area.

## D. BIOASSAY PROCEDURES

### 1. Criteria for Measurement

Bioassay procedures are performed by the Radiation Safety Office for users of H-3, I-125 and I-131. When quantities of these isotopes in excess of 10 mCi, 1 mCi and 1 mCi respectively are ordered, the RSO will inform the investigator that bioassays may be necessary. When quantities of H-3, I-125 or I-131 handled within a three month period exceed the values shown in Table 1 (for the appropriate process), a bioassay is required.When these quantities exceed 10% of the values in Table 1, a bioassay may be required. This will be determined by the Radiation Safety Officer and the Radiation Safety Committee at the time of authorization. It is the responsibility of the investigator to ensure that he and/or his lab workers receive bioassays when appropriate. The bioassay procedure for I-125 and I-131 consists of measuring radiation emitted from the thyroid using a sodium iodide detector placed on the throat. Action levels shown in Table 1 are activities in the thyroid. The bioassay procedure for H-3 consists of counting a urine sample in a liquid scintillation counter. Action levels shown in Table 1 are activity concentrations in the urine.

### 2. Frequency of Measurement

Each employee should have a bioassay performed before beginning work with quantities in excess of those stated above. When work has begun, measurements should be made at least as often as shown in Table 1. Routine exposure is defined as working with appropriate quantities more frequently than every two weeks. Non-routine exposure is work with appropriate activities less frequently than every two weeks. When measurements have been made every two weeks for 3 months and the Action Level 3 values have not been exceeded, measurements are required only every 3 months as long as no significant changes have been made in operating procedures. A delay between possible exposure and bioassay measurement of at least 6 hours is necessary for I-125 or I-131 unless excessive exposure is possible and a thyroid blocking agent is being considered.

3. Action Levels and Corresponding Actions

a.) If activity levels or concentrations exceed values given in Action Level 1 of Table 1, a survey will be performed by Radiation Safety, including interviews with persons involved in operations in the laboratory to determine the cause(s) of the exposures and evaluate the potential for further large exposures. Appropriate corrective actions will be implemented to lower the potential for further exposures. Employees will not be permitted to resume work with activities listed above until the corrective actions have been taken. The bioassay measurement should be repeated within one week for H-3 or within 2 weeks for I-125 or I-131 in order to evaluate the effectiveness of the corrective actions.

b.) If activity levels or concentrations exceed values given in Action Level 2 of Table 1, all steps listed in a.) must be taken. In addition, therapeutic procedures should be considered which could accelerate removal of the radionuclide from the body. Bioassays should be performed at approximately weekly intervals until activity levels or concentrations, are below values listed in Action Level 1 of Table 1.

Table 1. BIOASSAY ACTIVITY LIMITS AND ACTION LEVELS

| | H-3 | I-125 | | I-131 | |
|---|---|---|---|---|---|
| | NUCLEOTIDE PRECURSORS | VOLATILE OR DISPERSIBLE | BOUND TO NONVOLATILE AGENT | VOLATILE OR DISPERSIBLE | BOUND TO NONVOLATILE AGENT |
| PROCESS A OPEN ROOM | 10 mCi | 1 mCi | 10 mCi | 1 mCi | 10 mCi |
| PROCESS B FUME HOOD | 100 mCi | 10 mCi | 100 mCi | 10 mCi | 100 mCi |
| PROCESS C GLOVE BOX | 1 Ci | 100 mCi | 1 Ci | 100 mCi | 1 Ci |
| ACTION LEVEL 1 | 5 μCi/l | 0.12 μCi | | 0.04 μC | |
| ACTION LEVEL 2 | 50 μCi/l | 0.5 μCi | | 0.14 μCi | |
| ACTION LEVEL 3 | 3 μCi/l | 0.12 μCi | | 0.04 μCi | |
| NON-ROUTINE EXPOSURE MAXIMUM ELAPSED TIME FROM EXPOSURE TO MEASUREMENT | ONE MONTH | 10 DAYS | | | |
| ROUTINE EXPOSURE INITIAL FREQUENCY | EVERY TWO WEEKS | | | | |
| ROUTINE EXPOSURE LONG TERM FREQUENCY | EVERY THREE MONTHS | | | | |

## E. INSTRUMENTATION AND RADIOLOGICAL SAFETY EQUIPMENT

### 1. Survey Instruments

No radionuclide laboratory work shall be conducted unless proper survey equipment is available. It is the responsibility of the principal investigator to provide appropriate radiation detection equipment for work performed under his authorization. A portable survey instrument can be used to monitor work areas and lab personnel for many radionuclides used, however for low energy beta emitters such as H-3, C-14, and S-35 it is usually recommended that wipes be taken and counted in a liquid scintillation counter. More than one survey instrument may be required if different radionuclides are used. For instance, a GM counter is usually used to detect high energy beta and gamma emitters, a sodium iodide detector is recommended for low energy gamma emitters (such as I-125) and an ionization chamber is recommended if it is necessary to measure actual exposure rates.

All portable survey instruments used at AVAMC must be calibrated annually. This is performed by the Radiation Safety Office using a Cs-137 source. The calibration of this source is traceable to the National Bureau of Standards. Each scale (up to 1 R/hr) of an instrument is calibrated by placing the probe at such a distance from the source that the exposure rate is between one third and two thirds of full scale. If possible, the instrument is adjusted so that the measured exposure rate differs from the actual by less than 10% on each scale. For any scale on which the measured exposure rate differs from the actual by more than 10%, a correction factor will be determined. The radiation exposure rate from a reference check source is also measured during the annual calibration. This can be used for more frequent periodic checks of the instrument. For instruments used for quantitative measurements at lower energies (e.g. I-125, Tc-99m, Xe-133), the instrument should be calibrated using a source with an appropriate energy or calibration factors should be determined.

A list of all survey instruments and the calibration results are kept by the Radiation Safety Office. An investigator must therefore inform the Radiation Safety Office when he obtains a new survey instrument. The Radiation Safety Office has several types of survey instruments and should be contacted if a special survey is desired or if a survey instrument is not functioning. The Radiation Safety Office does not repair survey instruments.

2. DOSE CALIBRATOR

Nuclear Medicine Service shall maintain a dose calibrator for use in evaluating the radioactivity in radiopharmaceuticals. All radiopharmaceuticals are assayed for activity prior to administration. The instrument is properly zeroed and the removable chamber liner is always used. The accuracy of the activity must be 10% or better. The following checks of the dose calibrator must be made at the frequencies indicated.

a. Constancy of the dose calibrator is checked daily with a one millicurie Cs-137 source. A log of these readings is maintained. The activity expected is corrected for the 30 year half life of Cs-137. If the measured activity is not within +/- 5% of the calculated activity, the instrument must be repaired or adjusted.

b. Linearity of the dose calibrator is checked quarterly using the Cali-check device according to the manufacturers instructions.

c. Commonly used syringes and vials are assayed to determine a correction factor for a specified volume and radionuclide. Maintaining constant activity, this volume is adjusted over a reasonable clinical range to determine correction factors.

d. Accuracy of the dose calibrator is checked annually for several NBS traceable check sources (such as Cs-137, Co-57 and Ba-133) with energies and activities similar to that used in daily procedures. This accuracy check is performed either by the manufacturer or by the MCG Radiation Safety Office. If the measured activities do not agree with the calculated activities to within +/- 5%, the instrument should be repaired or adjusted. When a unit is installed, the reading for a 1 mCi Cs-137 standard is recorded on each radionuclide setting.

## IV. PERSONNEL TRAINING PROGRAM

The Notice to Employees sign (Appendix III) is posted in conspicuous locations for all employees who are occupationally exposed to radiation sources at AVAMC. This manual (Radiation Safety Guide) is issued to all approved principal investigators and should be made available to all radiation workers. Additional information is maintained in Nuclear Medicine Service and is available to all radiation workers. This includes:

Current Radioactive Materials License
Correspondence to and from the NRC concerning the license
License inspection reports
Radiation exposure records
NRC regulations (Title 10 - Chapter I
CODE of FEDERAL REGULATIONS)

### A. RESEARCH PERSONNEL

Staff members responsible for use of radioactive materials shall provide sufficient training to persons working under their authorizations to assure that radiation sources are used safely. The Radiation Safety Office will supplement the training with periodic radiation safety programs (at least annually). The Radiation Safety Course for laboratory personnel must be attended by new laboratory workers at the earliest possible time.

### B. ANCILLARY PERSONNEL

Building Management personnel are briefed periodically on the hazards and safety precautions in maintaining the laboratory.

### C. NUCLEAR MEDICINE PERSONNEL

Various topics pertaining to Nuclear Medicine and its safe practice are covered in monthly Nuclear Medicine Service sessions.

## D. TOPICS OF INSTRUCTION

Lectures to individuals listed in sections A-C of this chapter will include the following topics:

Basic nuclear and atomic physics
Basic counting statistics
Nuclear instrumentation
Radiation protection principals
Radiation biology
Quality control
Potential hazards associated with radioactive material
Radiation safety procedures
NRC regulations
Contents of the institutional license
Reporting of unsafe conditions
Emergency action
Film badge, bioassay and survey reports

# V. AUTHORIZATION, PROCUREMENT, RECEIPT AND DISPOSAL OF RADIOACTIVE MATERIALS

## A. AUTHORIZATION FOR USE OF RADIATION SOURCES

All persons at the AVAMC who use radiation sources must either be authorized or work under the supervision of one who is authorized.

Prerequisites for Authorization: The individual must

a. be a faculty member,

b. have adequate training and experience for the proposed uses (Adequacy of training and experience for the proposed uses is evaluated by the Radiation Safety Office and the Radiation Safety Committee when a proposal is submitted.),

c. have the use of adequate facilities and equipment to use radiation sources so that there is reasonable assurance that radiation exposure to all persons involved will be minimized.

Application blanks for authorization may be obtained from the Radiation Safety Office.

The completed application should be sent to the Radiation Safety Office where it will be reviewed. When the Radiation Safety Office concludes the evaluation, a recommendation will be made to the Radiation Safety Committee for: (a) authorization without additional restrictions, (b) authorization with restriction, or (c) denial of authorization. At least three members of the committee will review the application and recommendation. The three committee members must either approve the proposal as written or approve it with certain specified conditions unanimously. If one or more committee members does not approve it, the proposal must be modified to satisfy the objections or the full committee must meet to discuss it. A majority vote of the full committee membership is then necessary for approval.

In accepting an authorization, the applicant agrees to open his facility at all reasonable times for visits by the Nuclear Regulatory Commission and the Radiation Safety Office.

1. Non-human use of Radioactive Material

The use of each radionuclide should be described in sufficient detail to permit an evaluation of the radiation safety aspects of the work. This should include, but not be limited to:

a. the activity (in mCi or µCi) of each radionuclide to be kept in stock

b. the storage location

c. the activity to be used in an experiment run

d. the expected fate of the radionuclide during use, i.e., whether it is taken up in a compound, metabolized, evolved as a gas, remains in the precipitate, etc.

e. the method of containing the radionuclide during use

f. the means for collecting radioactive waste

g. the radiation surveys to be performed before, during, and after the experiment to monitor work areas and personnel for contamination

h. and other information pertinent to the evaluation of radiation safety aspects of the work being done

2. Human use of Radioactive Material

All persons at the AVAMC responsible for the administration of radioactive materials to humans for diagnosis or treatment of illness or for research purposes must be a physician or dentist.

The NRC has established criteria for acceptable training and experience for medical uses of radioactive materials. These criteria will be utilized in evaluations concerning well established procedures or for investigational procedures utilizing drugs for which a "Notice of Claimed Investigational Exemption for a New Drug" (IND) has been accepted by the Food and Drug Administration. In addition to NRC requirements, the VA also has specific procedures for routine in vivo studies. These procedures are stated in Medical Center Policy Memorandum No. 115-2-86 which is included as Appendix C in this manual. Routine diagnostic procedures are performed by Nuclear Medicine Service. Routine therapeutic procedures are performed by either Nuclear Medicine Service or the Georgia Radiation Therapy Center at MCG.

In instances where an investigator desires to use radioactive material in a procedure that is not well established and for which an IND has not been accepted by the Food and Drug Administration, the Radioactive Drug Research Committee (RDRC) can authorize the investigation. The RDRC can only approve investigations that encompass basic research, including studies of metabolism, human physiology, pathophysiology, or biochemistry. The RDRC cannot approve studies intended for immediate therapeutic, diagnostic, or similar purposes or to determine the safety and effectiveness of a drug in humans for such purposes (i.e. to carry out a clinical trial). The investigator must provide substantial information to the RDRC so that an appropriate evaluation can be made. The investigator must report to the RDRC each calendar quarter on the activities of the research conducted under such an authorization.

3. Radiation Producing Machines

All persons at the AVAMC who use a radiation producing machine must be a physician or dentist if humans are to be intentionally irradiated.

Licensed physicians or dentists that use radiation producing machines in routine diagnostic or therapeutic radiographic procedures on human patients are granted a general authorization provided that the equipment is operated by personnel trained in proper usage.

Experimental use of radiation producing machines on human patients or animals must have the specific approval of the Radiation Safety Committee prior to commencement.

A newly acquired radiation producing machine will not be placed in operation until an authorization has been granted by Medical Physics. The principal investigator must notify the Medical Physics when radiation producing machines are relocated.

## B. PROCUREMENT OF RADIOACTIVE MATERIALS

An investigator may order only radionuclides that he has been authorized to use by the Radiation Safety Committee (see procedures in sections A and C of this chapter).

Radionuclides used in Nuclear Medicine are ordered under the authorization of the Chief, Nuclear Medicine Service who is listed on the AVAMC - NRC license.

Orders for radionuclides used in research must be approved by the ACOS or administrative officer of Research Service or their designee. The Radiation Safety Office maintains the radioisotope inventory and periodically provides a list of radionuclides possessed by the approved investigators to Research Service. An order will not be approved if it would cause the PI's possession limit to be exceeded or if the PI is not approved for the radionuclide. After an order is approved, the order is placed by Supply Service and a copy of Form 2237 is sent to the Radiation Safety Office. The RSO then generates the Radioisotope Receipt and Disposal Form and sends a copy to the PI. If special radiation monitoring or a wipe survey is required, the PI is instructed to notify the RSO when the package arrives.

## C. RECEIPT OF RADIOACTIVE MATERIALS

Shipments of radioactive materials that arrive during normal working hours are received by the Nuclear Medicine Service or by the Receiving Warehouse. After receipt by the warehouse, the package should be taken to the appropriate laboratory by warehouse personnel. During off-duty hours security personnel will accept delivery of packages containing radioactive materials and place them in the refrigerator in Supply Processing and Distribution (SPD). They will be picked up by Nuclear Medicine or Research personnel on the next working day. These packages should not be handled more than absolutely necessary.

If the package is wet or appears to be damaged, immediately contact Radiation Safety and ask the carrier to remain at the Medical Center until it can be determined that neither he nor the delivery vehicle is contaminated. The VA Police have an emergency call list for Radiation Safety.

As soon as possible after the package arrives in the laboratory, lab personnel should carefully inspect it for damage. If the package appears damaged or wet, or if special monitoring is required, Radiation Safety should be contacted immediately.

Wear gloves when opening a package containing radioactive materials. Verify that the contents agree with the packing slip and requisition. Check the integrity of the final source container (i.e., inspect for breakage of seals or vials, loss of liquid, and discoloration of packaging material).

It should always be assumed that a source vial is contaminated; therefore, wear gloves and take other precautions to prevent the spread of contamination. To determine if the vial is contaminated, a wipe can be taken of the source vial and counted in an appropriate low level counting instrument.

Monitor the packing material and packages for contamination before discarding. If contaminated, treat as radioactive waste. If not contaminated, obliterate radiation labels before discarding in regular trash.

## D. TRANSFER OF RADIONUCLIDES

### 1. On Campus Transfers

When it is necessary to transfer radionuclides from one user or location to another, approval must be obtained from the Radiation Safety Office. When transfers are made from one principal investigator to another, receipt and disposal records must be generated to maintain accurate inventory records. When material is transferred from one room to another or one building to another, the Radiation Safety Office will need to evaluate the proposed transfer with respect to the packaging, container and method to ensure that it can be accomplished safely. Specifically, liquids should be transported only in sealed containers with secondary containment if there is a possibility of spillage, breakage, or leakage.

### 2. Off Campus Transfers

All transfers of radioactive materials off campus must be made through the Radiation Safety Office to ensure compliance with all license conditions and DOT regulations.

# VI. LABORATORY PROCEDURES FOR HANDLING RADIOACTIVE MATERIALS

## A. GENERAL RULES FOR THE SAFE USE OF RADIOACTIVE MATERIAL

It is the responsibility of those working with radioactive materials to protect themselves and others from radiation hazards arising from their work. Bad example and careless working habits may unnecessarily expose associates or contaminate facilities and cannot be tolerated.

An investigator is given permission to use radioactive materials by the Radiation Safety Committee; the investigator is made responsible for all operations in his laboratory. Specific responsibilities of the Principal Investigator, the individual users, and the Radiation Safety Office are given in Chapter I of this manual.

When working with radiation sources, both internal and external radiation exposures must be minimized. External exposures can be reduced by reducing time spent and increasing distance when handling radiation sources and by using appropriate shielding. Internal exposures can be eliminated if proper contamination control procedures are observed. The following rules should be understood and practiced in all radioisotope laboratories.

1. Designate and label the radioactive work area(s). Plan your work with safety in mind! Consider the consequences of leakage or equipment failure. Choose non-porous benchtops. Cover work surfaces with absorbent paper that has plastic backing to protect furniture and facilitate cleanup. Make use of secondary containers (eg., trays) to help confine liquids if spilled.

2. When contamination is possible, wear a lab coat and gloves. Change disposable gloves frequently when handling contaminated items. Potentially contaminated lab coats should remain in the laboratory.

3. Designate and label a storage area for radioisotopes. Radioisotopes shall be kept in the designated storage area when not in immediate use.

4. Stock the laboratory with plastic or rubber gloves, lab coats, warning tags and labels, appropriate survey/counting instruments, forms for necessary records, plastic bags and tape for waste disposal, absorbent paper, etc. The use of good procedures is greatly facilitated by having proper tools and supplies at hand.

5. Designate and label a "hot" sink for radioisotope disposal and cleaning radioactive glassware. Tag the sink to provide a warning that it must be surveyed before plumbing work is done.

6. When possible, use remote handling devices such as tongs or forceps and work behind a protective shield when handling significant quantities of gamma or high energy beta emitters. Heavy rubber or leather gloves can be used when working with high energy beta emitters.

7. Confine work with gaseous, volatile or dust-forming radioactive material to hoods or glove boxes.

8. No extensive radiochemical work should be performed with hazardous amounts of material until the procedure has been tested with a dummy or dry run.

9. Areas in which radioisotopes are used should be uncluttered. General rules for a good chemistry laboratory are applicable.

10. Radioactive materials should not be left in an uncovered container. Glass containers should be placed inside larger break-resistant secondary containers. Containers should be clearly labelled as to the nature of their contents.

11. Eating, drinking, smoking and the application of cosmetics are prohibited in areas where unsealed radioactive materials are being handled.

12. Pipetting or similar operations by mouth suction (or blowing) is prohibited. (This includes pipetting not only radioactive materials, but also nonradioactive materials in areas where radioactive materials are used.)

13. Monitor hands, feet, clothing and work area routinely for contamination. Hands should be washed routinely after handling radioactive material, especially before eating.

14. If provided, personnel monitoring badges must be worn in restricted areas. Since a badge report is a legal record, a badge should be worn only by the individual it is issued to and only while performing duties at or for the V. A. Medical Center, Augusta, GA.

15. Dispose of radioactive waste only in specially designated receptacles. Only designated sinks are to be used for low level aqueous radioactive liquids.

16. Familiarize yourself with the procedures for radioactive decontamination. The person responsible for a spill is also responsible for the cleanup.

17. Transport radioactive materials in double containers (in case of a fall) which are adequately shielded for the radionuclide being transported.

18. Do not leave radioactive materials unattended in places where unauthorized persons may handle or remove them. Return to storage as soon as possible after use.

19. Use syringe shields for routine preparation of patient doses and administration to patients whenever practicable.

20. Procedures set forth in the Nuclear Medicine Department Procedure Manual will be followed when eluting a generator and testing the elution for molybdenum 99 breakthrough. Chromatography studies will be performed to determine tagging efficiency of prepared radiopharmaceuticals using procedures in the manual. The activity obtained per elution, quantity of molybdenum 99 present, and the tagging efficiency of prepared radiopharmaceuticals will be recorded in a log book.

21. Assay each patient dose in the dose calibrator and record the results in a log book prior to administration. Do not use any doses that differ from the prescribed dose by more than 10%.

22. Survey the not lab for contamination after each procedure or at the end of the day. Decontaminate if necessary.

## B. STORAGE OF RADIONUCLIDES

Radionuclides must be stored to permit access only by the principal investigator (PI) and those whom he designates. Rooms in which radioactive material is stored must be locked when the PI or lab worker is not present. If the PI does not have complete control over the storage area, the radioactive material must be in a locked refrigerator, freezer or cabinet. Each area and room where radionuclides are stored must be posted with a radioactive materials sign. Radiation levels around storage areas should be measured routinely. If radiation levels could exceed two millirem per hour, the area must be posted with a radiation area sign. Proper signs can be obtained from the Radiation Safety Office.

Refrigerators used for radionuclide storage must not be used to store food.

Radionuclides which could become airborne must be stored in a ventilated hood. The control switch for the hood ventilation shall remain in the "ON" position.

All radionuclide storage containers must bear the radiation symbol and be labeled with the type of radionuclide, its activity, and the date the activity was recorded. It should also be clear either by the storage location or by markings on the container who the material belongs to.

## C. BIOHAZARDOUS RADIOACTIVE MATERIAL

For procedures that involve biohazards (biologic, carcinogenic and toxic substances and/or organisms that can endanger the health and safety of personnel, patients or the public), as well as radiation hazards, the AVAMC Biohazards Committee must be consulted.

## D. PROTECTIVE CLOTHING

Protective clothing must be worn whenever contamination is possible. Outer protective clothing as well as personal clothing must be routinely monitored each day or when radionuclide work is completed. USE DISPOSABLE PLASTIC GLOVES TO PROTECT YOUR HANDS. Coveralls, laboratory coats or other protective garments worn in the laboratory are not to be worn elsewhere, especially in places where smoking, eating and drinking are allowed. Articles which become contaminated shall be decontaminated or marked and stored until activity has decayed to an acceptable level or disposed of. Contaminated clothing shall not be sent to the laundry.

## E. USE OF RADIOACTIVE MATERIALS IN ANIMALS

The Radiation Safety Committee authorizes some investigators to administer radioactive materials to animals during research. If the services of the Animal Research Facility are required in housing of, care of, or experimentation with lab animals, they must be notified well in advance of commencement of experimentation. The following rules should be observed when animals containing radioactive materials must be housed:

1. All animals which have been given radioactive material should be isolated from the other animals that do not contain radioactive material. There is a room specifically designated for radioactive animals in the animal facility.

2. Cages housing animals containing radioactive materials should be labeled with an appropriate radioactive materials warning signs.

3. The "Notice to Employees" and "Emergency Procedures" should be posed in a conspicuous place within the animal facility.

4. The bottom of the cages should be lined with absorbent paper pads with plastic backing or other appropriate absorbent materials.

5. A radioactive material waste disposal can should be in the area where the animals are located for use when cleaning the cages.

6. Animal attendants should use disposable gloves when handling waste from animals containing radioactive material. This should be disposed of in the radioactive materials waste disposal can.

7. Washing the animal cages and collection baskets at the end of the experiment should be performed as usual after they are decontaminated by laboratory personnel.

## F. RADIONUCLIDE LABORATORY CLASSIFICATION

Three factors influence the hazard classification of a laboratory:

1) The maximum activity stored or used in the area.
2) Relative radiation hazard of the radionuclides used.
3) The type of use in terms of the relative hazard of the handling procedures.

The Nuclear Regulatory Commission (Reg. Guide 8.23) recommends that if less than 200 μCi is used at any one time, a monthly survey should be performed. Higher activities may require more frequent surveys. Since different radionuclides have different hazards associated with them, the activity of each radionuclide is normalized to take into account the relative hazards. The normalized activity concept combines the three factors listed above into a single term as given by the following equation:

$$N_A = C_A / (IT \times OF + EH)$$

where $C_A$ = 7.4 - a constant that normalizes to I-131 which is the most hazardous radionuclide commonly used in open form in Biomedical research, diagnosis and therapy.

$N_A$ (normalized activity) - maximum activity used or stored in a lab

**IT** (Internal Toxicity) - The toxicity of a radionuclide in the body depends on the type and energy of radiations emitted, the organs in which the radionuclide concentrates and the effective half-life. The IT value assigned is equal to the inverse of the Annual Intake Limit (oral - in mCi) for the radionuclide as given by ICRP 30 (see Table 2).

**OF** (Operational Factor) - This factor modifies the IT value to account for the potential hazard of the operational procedures, in other words, the potential for dispersal and intake of the radioactive material (see Table 3).

**EH** (External Hazard) - The external hazard of a radionuclide is directly proportional to the radiation energy and number of photons or particles emitted per disintegration (see Table 2). The values in Table 2 were calculated by taking the inverse of the activity which would deliver the MPD to the whole body (5 rem) if a worker were 1 m from the source, 40 hours per week, 50 weeks per year.

Table 2. MAXIMUM NORMALIZED ACTIVITY FOR MONTHLY SURVEY FREQUENCY

| RADIONUCLIDE | IT | EH | ACTIVITY (mCi) |
|---|---|---|---|
| AM241 | 4.9E-03 | 7.4E+02 | 0.010 |
| IR192 | 1.5E-01 | 9.3E-01 | 6.884 |
| RU103 | 9.4E-02 | 5.3E-01 | 10.000 |
| MO99 | 1.2E-01 | 9.3E-01 | 7.101 |
| P32 | 0.0E+00 | 1.9E+00 | 4.008 |
| CA45 | 0.0E+00 | 6.2E-01 | 10.000 |
| C14 | 0.0E+00 | 4.1E-01 | 10.000 |
| CS137 | 1.1E-01 | 9.2E+00 | 0.792 |
| CL36 | 0.0E+00 | 6.2E-01 | 10.000 |
| CR51 | 5.5E-03 | 3.7E-02 | 10.000 |
| GD153 | 1.0E-02 | 1.9E-01 | 10.000 |
| GA67 | 3.2E-02 | 1.2E-01 | 10.000 |
| AU198 | 7.9E-02 | 9.3E-01 | 7.385 |
| H3 | 0.0E+00 | 1.2E-02 | 10.000 |
| IN111 | 7.2E-02 | 1.9E-01 | 10.000 |
| I123 | 2.4E-02 | 3.7E-01 | 10.000 |
| I125 | 1.7E-03 | 3.7E+01 | 0.200 |
| I131 | 7.3E-02 | 3.7E+01 | 0.200 |
| FE55 | 0.0E+00 | 1.2E-01 | 10.000 |
| FE59 | 2.4E-01 | 1.2E+00 | 5.038 |
| NI63 | 0.0E+00 | 1.2E-01 | 10.000 |
| RB87 | 0.0E+00 | 9.3E-01 | 8.016 |
| NA22 | 4.3E-01 | 1.9E+00 | 3.248 |
| SR85 | 1.0E-01 | 4.1E-01 | 10.000 |
| SR90 | 0.0E+00 | 3.7E+01 | 0.200 |
| S35 | 0.0E+00 | 9.3E-02 | 10.000 |
| TC99M | 2.3E-02 | 1.2E-02 | 10.000 |
| TL201 | 2.9E-03 | 6.2E-02 | 10.000 |
| XE133 | 5.3E-03 | 0.0E+00 | 10.000 |
| ZN65 | 1.1E-01 | 3.7E+00 | 1.944 |
| CO57 | 3.6E-02 | 1.9E-01 | 10.000 |
| CO60 | 5.0E-01 | 5.3E+00 | 1.281 |
| RB86 | 2.0E-02 | 1.9E+00 | 3.966 |
| AU195 | 4.1E-04 | 1.9E-01 | 10.000 |
| BA133 | 7.1E-02 | 6.2E-01 | 10.000 |
| CE141 | 1.3E-02 | 6.2E-01 | 10.000 |

Table 3. OPERATIONAL FACTORS FOR USE OF RADIOACTIVE MATERIALS AS RECOMMENDED BY ICRP PUBLICATION #25

Operational Factors for Laboratories

| | |
|---|---|
| Simple storage. | 0.01 |
| Very simple wet procedures, involving only a few steps | 0.1 |
| Normal chemical operations | 1.0 |
| Complex (wet) operations (e.g. operations with complex glass apparatus) or operations with multiple procedures | 10 |
| Work with volatile materials | 10 |
| Simple dry operations | 10 |
| Dry and dusty operations (e.g. grinding) | 100 |

## G. LABORATORY SURVEY PROCEDURES

The Radiation Safety Office performs monthly surveys of laboratories. Personnel utilizing radioactivity are encouraged and sometimes required to perform radiation surveys more frequently in order to determine the extent of radioactive contamination and to ascertain that all waste and stock material has been properly disposed of or stored.

Routine surveys should be carried out in two parts to determine the radiation level and the removable contamination level.

### 1. Radiation Level

Monitor the area with a radiation survey meter sufficiently sensitive to detect 0.1 mR/hr. The results of this survey should be recorded.

### 2. Contamination Level

A series of wipe tests should be taken in all areas where activity is handled in unsealed form. The location of wipe tests should be indicated on a survey form and should be chosen for maximum probability of contamination, e.g. areas where individual doses are drawn up, frequent pipetting carried out.

Floors, particularly adjacent to doorways, lead syringe shields, and door and drawer handles should also be wipe test frequently. Care should be taken that cross contamination does not occur.

An end window GM or gas flow proportional counter normally may be used for assaying beta emitters above C-14 energies; low energy beta emitters such as C14 and H-3 will require liquid scintillation counting.

A gamma-scintillation counter (e.g. NaI well counter) should be used for pure gamma emitters. Make sure that the analyzer threshold is set below the lowest gamma energy used in the lab (usually I-125).

Record a background count of 5-10 minutes using the same counting conditions used with the wipes.

3. Acceptable Limits

a. Radiation Limits (whole body only)

i. Non-controlled area:

Individuals must not receive more than 2 mrad in any one hour, or more than 100 mrad in 7 consecutive days, or more than 500 mrad in any one year.

ii. Controlled area:

If an area is controlled for purposes of radiation protection, then the area must be clearly marked as a Radiation Area or High Radiation Area, the radiation level be posted and access by unauthorized or uninformed personnel must be prevented.

b. Contamination Limits

An individual wipe test should routinely cover approximately 100 square cm. Decontamination is required if the removable contamination level exceeds 220 dpm/100 sq.cm. for moderate and high toxicity radionuclides or 2200 dpm/100 sq.cm. for slight and moderate toxicity radionuclides.

## H. SEALED SOURCE LEAK TESTS

Sealed sources in use will be tested for leakage every six months. The test will be capable of detecting 0.005 microcuries. Damaged or leaking sources will be disposed of, corrective actions taken, and appropriate reports will be filed by the Radiation Safety Officer. Sources in storage need not be leak tested until returned to service.

# VII. RADIOACTIVE WASTE DISPOSAL

## A. GENERAL RULES

Radioactive waste in laboratories must be stored in the proper manner as specified in the following sections until it is picked up by Radiation Safety. An accurate record should be kept of all material placed in each container. The Radioactive Material Receipt and Disposal Form may be used for this purpose. When approximately 3/4 full, the bag or box should be properly sealed and a Radioactive Waste Disposal Tag filled out completely, signed and attached to it. Radiation Safety personnel will pick up radioactive waste weekly at designated times and locations for each building (contact the Radiation Safety Office for schedule). Non-radioactive items must not be put in the radioactive waste container. The waste must be carefully segregated into the different categories specified below. Waste bags or boxes containing improperly packaged or non-radioactive waste will be refused until properly repackaged by laboratory personnel.

Short-lived radionuclide waste (halflife of a few months or less) should be segregated from long-lived radionuclide waste if possible.

All uncapped syringes and other sharp objects must be placed in a box or other such container before being put into the plastic bag.

Processing of radioactive waste is currently being performed by the Radiation Safety Office of the Medical College of Georgia as part of an overall radiation safety contract between the two institutions. The Old University Hospital building is the processing facility.

## B. SOLID WASTE

Waste containers and specially marked yellow transparent bags for dry radioactive waste are provided for laboratories using radionuclides. Contact the Radiation Safety Office when additional containers are needed.

The bag should be placed inside the waste can and sealed with tape when it is approximately 3/4 full.

No liquid material or scintillation vials may be placed in the dry waste container. Even small quantities of liquids remaining in vials, bottles, tubes, syringes, etc. are unacceptable in the dry waste container. It is preferable that the burnable material be separated from the non-burnable solid waste.

## C. LIQUID SCINTILLATION VIALS

### 1. Organic-based fluids

Liquid scintillation vials containing organic-based fluids (toluene or xylene) must be segregated from other radioactive liquid wastes. Vials or plastic insert bags containing radioactive liquid scintillation waste may be held for disposal as is or the contents may be poured into high quality jugs designated for radioactive liquid scintillation waste only. If the vials are not emptied, it is preferred that they be placed in the original cardboard trays and box. A single waste tag may be used for each box (5 trays). Alternatively, they can be double-bagged using the specially marked plastic radioactive waste bags. Plastic and glass vials should be separated.

Liquid scintillation vials or plastic insert bags that indicate background concentration levels when counted in an appropriate counting instrument, need not be disposed of as radioactive waste. They may be disposed of via standard non-radioactive waste methods.

### 2. Non-organic-based fluids

Liquid scintillation fluid that has been approved by the Environmental Protection Agency to be disposed of into the sanitary sewer system may be disposed of by the individual laboratory personnel as aqueous bulk liquid. It may also be sent to the Radiation Safety Office for disposal (it should be kept separate from other types of waste including organic-based liquid scintillation fluids).

## D. AQUEOUS BULK LIQUID

Radioactive waste that is soluble or readily dispersible in water may be disposed of into the sanitary sewer system. Accurate records must be kept of all materials disposed of in this manner and entered on the Radioactive Material Receipt and Disposal Form. The sink used for such disposal must be clearly labelled and not used for other purposes where contamination could result. Regulations and license conditions limit the activity of radioactive liquids that can be disposed of into the sewer. The daily limits allowed each laboratory are given in Table 4. Since these values are based on institutional limits, greater amounts may be disposed of if necessary, but the Radiation Safety Office should be contacted before this is done.

## E. NON-AQUEOUS BULK LIQUID

Bulk liquid that is not readily dispersible in water should be poured into a high quality jug provided by Radiation Safety.

## F. SHORT HALF-LIFE WASTE

This waste is collected as usual by Radiation Safety, stored for decay, and subsequently disposed of as regular trash. Labels containing the radiation symbol, the words "Radioactive Material", etc. should be removed or defaced before disposal. If laboratory personnel wish to store the waste for decay in the lab, Radiation Safety must be contacted for approval.

## G. ANIMAL CARCASSES

Animal carcasses containing radioactive material, as well as other biological material, should be double bagged -- the inner bag unmarked and the outer bag a specially marked radioactive waste bag. The completed waste tag must be taped to the outside of the bag. It is then taken to one of the specially-marked freezers in the R & E building or Dugas Building.

## H. BIOLOGICALLY OR CHEMICALLY HAZARDOUS WASTE

Special arrangements must be made before Radiation Safety will accept radioactive waste that also contains biologically hazardous substances (such as blood, infectious organisms, etc.) or chemically hazardous substances (such as strong acids, carcinogens, etc.). This type of waste may need to be autoclaved or packaged in special containers to prevent Radiation Safety personnel from being exposed to those hazards when processing the waste.

Table 4. SEWER DISPOSAL LIMITS

| ISOTOPE | VA µCi/day | PI µCi/day |
|---|---|---|
| Am241 | 1520 | 61 |
| Au198 | 4000 | 160 |
| C14 | 4000 | 160 |
| Ca45 | 3420 | 137 |
| Cl36 | 4000 | 160 |
| Co57 | 4000 | 160 |
| Co60 | 4000 | 160 |
| Cr51 | 4000 | 160 |
| Cs137 | 4000 | 160 |
| Fe55 | 4000 | 160 |
| Fe59 | 4000 | 160 |
| Ga67 | 4000 | 160 |
| Gd153 | 4000 | 160 |
| H3 | 4000 | 160 |
| I123 | 4000 | 160 |
| I125 | 76 | 3 |
| I131 | 114 | 5 |
| In111 | 4000 | 160 |
| Ir192 | 4000 | 160 |
| Mo99 | 4000 | 160 |
| Na22 | 4000 | 160 |
| Ni63 | 4000 | 160 |
| P32 | 4000 | 160 |
| Rb87 | 4000 | 160 |
| Ru103 | 4000 | 160 |
| S35 | 4000 | 160 |
| Sr85 | 4000 | 160 |
| Sr90 | 114 | 5 |
| Tc99m | 4000 | 160 |
| Tl201 | 4000 | 160 |
| Xe133 | 0 | 0 |

## VIII. PROCEDURES FOR OPERATING X-RAY MACHINES

Only persons whose presence is necessary shall be in the radiographic area during exposure. Protective clothing of at least 0.25 mm lead equivalent shall be provided and shall be worn by all individuals required to be in controlled areas except for the following circumstances: When the individuals are entirely behind protective barriers while the equipment is energized, or when a radiation protection survey indicated that the exposure rate in the occupied area is less than 5 mR in any one hour.

When patient, animal, or film must be held in position for radiography, mechanical supporting or restraining devices or other means of immobilization should be used. If such a device is not available or practical, the individual shall wear protective gloves having at least 0.5 mm lead equivalence, a protective apron of at least 0.25 mm lead equivalence, and shall keep all parts of the body out of the useful beam.

Women of childbearing age and individuals under 18 years of age, shall not support or hold patients, animals or film during radiation exposures.

Personnel involved in radiographic procedures should wear monitoring devices. Exceptions to this policy can be made for individuals who could not receive a dose in excess of 25% of the MPD in a calendar quarter (see Chapter III).

The gonads of children and persons of reproductive age should be protected from primary radiation during any x-ray examination or treatment by the use of a special gonad shield or apron when this will not interfere with the clinical objectives.

The operator should normally stand behind a protective barrier when making an exposure. This barrier shall have a viewing window that enables the operator to view the patient during the exposure.

For portable equipment, protective aprons of at least 0.25 mm lead equivalent shall be available and used by the operator and any other persons required to be in the room and within 2 meters of the patient and/or x-ray tube during an exposure. The operator must warn all persons in the room that an exposure is about to be made and allow enough time for them to leave.

Portable x-ray units should be used in patient rooms only in cases when medical reasons prohibit the patient from being taken to the Radiology Department.

As a general principle, the exposure to the patient shall be kept to the practical minimum consistent with clinical objectives.

## APPENDIX I. RECOMMENDATIONS FOR PREGNANT WORKERS EXPOSED TO RADIATION SOURCES

The following is a summary of conclusions and recommendations for pregnant radiation workers by the National Council of Radiation Protection and Measurements (NCRP) in Report No. 53 entitled "Review of NCRP Radiation Dose Limit for Embryo and Fetus in Occupationally-Exposed Women":

A. On the basis of the current review, the NCRP has decided to make no change in the current recommendation of its radiation dose limit to the unborn. The NCRP recommendation is restated here as follows:

> During the entire gestation period, the maximum permissible dose equivalent to the embryo-fetus from occupational exposure of the expectant mother should be 0.5 rem.

B. The basic reason for the identity of position in 1977 and 1971 with respect to the recommendation that the radiation dose limit should be 0.5 rem is that since the preparation of the 1971 report there has been no new evidence concerning teratogenic or carcinogenic effects of irradiation of the embryo-fetus that would justify a change in the limit in either direction.

C. It is implicit in this position and recommendation that women who can reasonably be expected to be pregnant should not, in certain instances, be exposed to the same radiation environment as women who are not considered fertile or as men. This applies particularly to conditions where radiation workers can receive dose equivalents of 0.5 rem or more in short periods. However, any special restrictions that need to be imposed on potentially pregnant women depend on a number of circumstances. These include amount and temporal distribution of radiation exposure and such matters as whether female employees agree to or are asked to disclose pregnancy to management, and how soon after conception a pregnancy can be recognized. Because of these variables, and perhaps others of a legal nature as well, it appears impracticable for NCRP to make detailed recommendations concerning modes of practical implementation of the recommended dose limits.

D. The recommendations of the NCRP are directed at protection of the embryo-fetus as being involuntarily subjected to radiation exposure as a consequence of the occupational exposure of the expectant mother.

## APPENDIX II. SPECIAL PROCEDURES FOR VARIOUS RADIONUCLIDES

### A. XENON-133

Between 5 and 20 studies involving administration of Xe-133 are usually performed each week. This involves studies of lung ventilation/perfusion and regional cerebral blood flow. The approximate activities used are 5 - 20 mCi for lung and 10 - 50 mCi for rCBF studies. The xenon gas will be procured from a supplier that distributes the product for human use in accordance with the Federal Food, Drug and Cosmetic Act.

A RADX - Xenon Kow system will be used for dispensing the xenon. The system will be used and stored in a laminar flow hood (minimum face velocity of 100 feet/minute).

Exhaust from the area will be via a 1160 cfm ventilation unit that discharges directly outside. Complete discharge of 1000 mCi of xenon per 40 hour week would result in a concentration of approximately $1.3 \times 10^{-8}$ µCi/ml. Since only a small fraction of the activity would actually be released in the facility, xenon air concentrations would be substantially less than the levels allowed by 10CFR20 ($3 \times 10^{-7}$ µCi/ml).

The xenon for lung ventilation/perfusion studies will be administered with a RADX Ventil-Con II system which includes a xenon trap and a xenon detector/alarm. A xenon gas administration system is used for regional cerebral blood flow studies. A Victoreen XenAlert monitor is used to monitor xenon concentrations in the study area. An Atomic Development Corporation emergency room air radio-decontamination unit will be available for emergency use in the event of a xenon release.

## B. HYDROGEN-3, CARBON-14, and SULFUR-35

H-3, S-35 and C-14 emit low energy beta radiation (H-3 - .018 MeV, S-35 - .167 MeV and C-14 - .156 MeV), and therefore present no appreciable external radiation exposure hazard. Personnel working with H-3, S-35, and C-14 do not require a film badge monitor.

Shipments of H-3, S-35, and C-14 should be opened in a hood and inspected for damage and contamination. Most shipments can be stored safely in a laboratory refrigerator or freezer. If the material labeled with H-3, S-35, or C-14 is volatile, it should be stored and used in a hood.

Because of their low beta energy, H-3, S-35, and C-14 cannot readily be detected with a portable GM survey instrument. Therefore, in order to evaluate possible contamination of the laboratory, it is necessary to perform contamination smear surveys on a routine basis using dry filter paper smears. The smears should be counted in a liquid scintillation counting system. Areas showing removable contamination greater than amounts specified in Chapter II should be decontaminated and resurveyed.

Individuals who use H-3 in large quantities must have a urine analysis performed (see Chapter III. D. for requirements).

## C. IODINE-125 and IODINE-131

Special caution should be exercised when opening the shipping vials containing sodium iodide or other volatile iodinated compounds. Some of the I-125 and/or I-131 activity is released to the air upon opening the vial. This operation must be restricted to a well-ventilated hood (minimum 100 linear feet per minute). Wear disposable gloves when handling the packing materials and container and survey everything for contamination.

If possible the pH of the iodine solution should be maintained above 8.0. Low pH tends to increase the amount of I-125 or I-131 released to the air.

Disposable gloves should be worn when handling radioactive iodine. During labeling procedures or when handling volatile iodine materials, it is recommended that double gloving be used. The outer glove should be changed frequently to prevent absorption of I-125 or I-131 through the gloves.

The liquid radioactive waste container used for collection of I-125 or I-131 should be stored in the hood, and all liquid waste transfers to the container should be made in the hood. Wastes and other materials containing volatile iodine should be placed in a sealed container before removal from the hood.

A laboratory coat, or long protective disposable gloves should be worn to cover exposed skin surfaces on the arms during labeling procedures or handling of volatile I-125 or I-131. This will minimize the absorption of iodine into the body. The coat and gloves should be removed immediately after completion of procedures involving volatile iodine. The used laboratory coat should be checked for contamination. Consideration should be given to the use of disposable laboratory coats for labeling procedures.

Absolutely no pipetting of radioactive materials by mouth should be allowed.

A GM survey instrument (for I-131) or a NaI survey instrument (for I-125) should be used to survey hands, clothing and equipment after labeling procedures to assure that contamination is not present. Hands should be thoroughly washed after handling any radioactive iodine.

Lead may be used to shield I-125 labeling columns, stock vials, collection containers, etc. A survey of the area with a GM survey meter will indicate the amount of shielding necessary.

Routine contamination smear surveys should be made of the laboratory, and of the labeling area after each use. Spills should be cleaned up immediately, and a resurvey made of the spill area to be sure it is decontaminated.

Each person using large quantities of I-125 or I-131 per experiment must have a thyroid count. (See Chapter III.D.)

## D. PHOSPHORUS-32

All P-32 shipments should be opened in a radionuclide hood and inspected for damage and contamination.

Because of the high radiation exposure rate*, the P-32 stock solution vial should not be handled with the hands. Use remote handling tools. Never place hands or any other part of the body over an open unshielded vessel containing large quantities of P-32 in relatively small volumes of liquid. In 1 ml of water the surface dose rate for 1 mCi of P-32 = 780 rads/hr or 13 rads/min. Because of these very high exposure rates, the handling of uncovered vessels (open unshielded top) present a serious potential for excessive and unnecessary radiation dose to the hands and face.

The stock solution vial must be stored in a shield which provides adequate protection to personnel. Quantities of P-32 greater than 0.5 millicuries should be placed in a lucite and lead beta radiation shield.

Personnel radiation monitors (whole body and extremity) must be worn by individuals who handle stock solutions of 0.5 millicuries or more on a routine basis.

Routine contamination smear surveys should be made of all use areas in the laboratory on a routine basis. The smears should be counted in a liquid scintillation counting system, and any areas indicating removable activity greater than amounts specified in Chapter II should be decontaminated and resurveyed.

The Radiation Safety Officer should be contacted immediately in the event of any major spills or other emergencies. Prior to initiating new experiments involving large quantities of P-32 contact the Radiation Safety Officer to discuss radiation hazards during the initial experiment.

Glasses provide protection for the eyes from P-32 beta radiation.

* Exposure rates from 1 mCi of P-32 over 1 cm of skin
2000 rads/hr - at surface
200 rads/hr - at 1 cm
22 rads/hr - at 10 cm

UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, D.C. 20555

# NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION (PART 20); NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS (PART 19); EMPLOYEE PROTECTION

## WHAT IS THE NUCLEAR REGULATORY COMMISSION?

The Nuclear Regulatory Commission is an independent Federal regulatory agency responsible for licensing and inspecting nuclear power plants and other commercial uses of radioactive materials.

## WHAT DOES THE NRC DO?

The NRC's primary responsibility is to ensure that workers and the public are protected from unnecessary or excessive exposure to radiation and that nuclear facilities including power plants are constructed to high quality standards and operated in a safe manner. The NRC does this by establishing requirements in Title 10 of the Code of Federal Regulations (10 CFR) and in licenses issued to nuclear users.

## WHAT RESPONSIBILITY DOES MY EMPLOYER HAVE?

Any company that conducts activities licensed by the NRC must comply with the NRC's requirements. If a company violates NRC requirements, it can be fined or have its license modified, suspended or revoked.

Your employer must tell you which NRC radiation requirements apply to your work and must post NRC Notices of Violation involving radiological working conditions.

## WHAT IS MY RESPONSIBILITY?

For your own protection and the protection of your co-workers, you should know how NRC requirements relate to your work and should obey them. If you observe violations of the requirements, you should report them.

## HOW DO I REPORT VIOLATIONS?

If you believe that violations of NRC rules or of the terms of the license have occurred, you should report them immediately to your supervisor. If you believe that adequate corrective action is not being taken, you may report this to an NRC inspector or the nearest NRC Regional Office.

## WHAT IF I WORK IN A RADIATION AREA?

If you work with radioactive materials or in a radiation (controlled) area, the amount of radiation exposure that you may legally receive is limited by the NRC. The limits on your exposure are contained in sections 20.101, 20.103, and 20.104 of Title 10 of the Code of Federal Regulations (10 CFR 20). While those are the maximum allowable limits, your employer should also keep your radiation exposure as far below those limits as is "reasonably achievable."

## MAY I GET A RECORD OF MY RADIATION EXPOSURE?

Yes. Your employer is required to tell you, in writing, if you receive any radiation exposure above the limits set in the NRC regulations or your employer's license. In addition, if your job involves radiation, you may request from your employer a record of your annual radiation exposures and a written report of your total exposure when you leave your job.

## HOW ARE VIOLATIONS OF NRC REQUIREMENTS IDENTIFIED?

NRC conducts regular inspections at licensed facilities to assure compliance with NRC requirements. In addition, your employer and site contractors conduct their own inspections to assure compliance. All inspectors are protected by Federal law; interference with them may result in criminal prosecution for a Federal offense.

## MAY I TALK WITH AN NRC INSPECTOR?

Yes. Your employer may not prevent you from talking with an NRC inspector and you may talk privately with an inspector and request that your identity remain confidential.

## MAY I REQUEST AN INSPECTION?

If you believe that your employer has not corrected violations involving radiological working conditions, you may request an inspection. Your request should be addressed to the nearest NRC Regional Office and must describe the alleged violation in detail. It must be signed by you or your representative.

## HOW DO I CONTACT THE NRC?

Notify an NRC inspector on-site or call the nearest NRC Regional office collect. NRC inspectors want to talk to you if you are worried about radiation safety or other aspects of licensed activities, such as the quality of construction or operations at your plant.

## CAN I BE FIRED FOR TALKING TO THE NRC?

No. Federal law prohibits an employer from firing or otherwise discriminating against a worker for bringing safety concerns to the attention of the NRC. You may not be fired or discriminated against because you:

- ask the NRC to enforce its rules against your employer;
- testify in an NRC proceeding;
- provide information or are about to provide information to the NRC about violations of requirements;
- are about to ask for or testify, help, or take part in an NRC proceeding.

## WHAT FORMS OF DISCRIMINATION ARE PROHIBITED?

No employer may fire you or discriminate against you with respect to pay, benefits, or working conditions because you help the NRC.

## HOW AM I PROTECTED FROM DISCRIMINATION?

If you believe that you have been discriminated against for bringing safety concerns to the NRC, you may file a complaint with the U.S. Department of Labor. Your complaint must describe the firing or discrimination and must be filed within 30 days of the occurrence.

Send complaints to:

Office of the Administrator
Wage and Hour Division
Employment Standards Administration
U.S. Department of Labor
Room 53502
200 Constitution Avenue, N.W.
Washington, D.C. 20210

or any local office of the Department of Labor, Wage and Hour Division. Check your telephone directory under U.S. Government listings.

## WHAT CAN THE LABOR DEPARTMENT DO?

The Department of Labor will notify the employer that a complaint has been filed and will investigate the case.

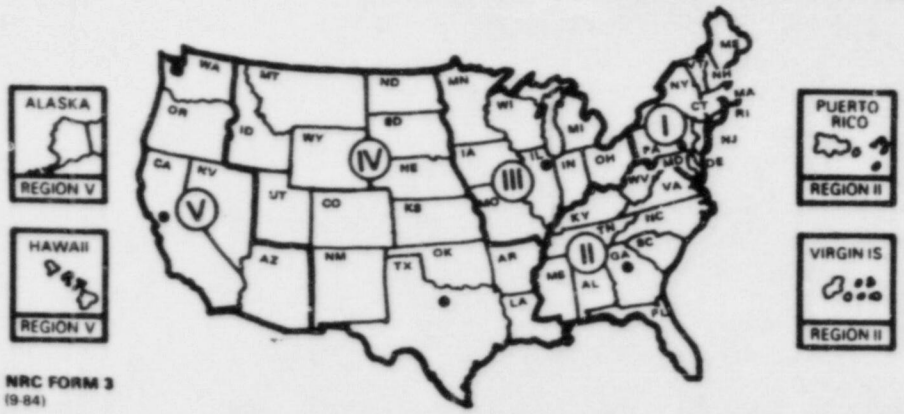
If the Department of Labor finds that your employer has unlawfully discriminated against you, it may order you to be reinstated, receive back pay, or be compensated for any injury suffered as a result of the discrimination.

## WHAT WILL THE NRC DO?

The NRC may assist the Department of Labor in its investigation. NRC may conduct its own investigation where necessary to determine whether unlawful discrimination has prevented the free flow of information to the Commission. Also, if the NRC or Department of Labor finds that unlawful discrimination has occurred, the NRC may issue a Notice of Violation to your employer, impose a fine, or suspend, modify, or revoke your employer's NRC license.

## UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICE LOCATIONS

**A representative of the Nuclear Regulatory Commission can be contacted at the following addresses and telephone numbers. The Regional Office will accept collect telephone calls from employees who wish to register complaints or concerns about radiological working conditions or other matters regarding compliance with Commission rules and regulations.**




**Regional Offices**

| REGION | ADDRESS | TELEPHONE |
|---|---|---|
| I | U.S. Nuclear Regulatory Commission<br>Region I<br>631 Park Avenue<br>King of Prussia, PA 19406 | 215 337-5000 |
| II | U.S. Nuclear Regulatory Commission<br>Region II<br>101 Marietta St., N.W., Suite 2900<br>Atlanta, GA 30323 | 404 221-4503 |
| III | U.S. Nuclear Regulatory Commission<br>Region III<br>799 Roosevelt Road<br>Glen Ellyn, IL 60137 | 312 790-5500 |
| IV | U.S. Nuclear Regulatory Commission<br>Region IV<br>611 Ryan Plaza Drive, Suite 1000<br>Arlington, TX 76011 | 817 860-8100 |
| V | U.S. Nuclear Regulatory Commission<br>Region V<br>1450 Maria Lane, Suite 210<br>Walnut Creek, CA 94596 | 415 943-3700 |

NRC FORM 3
(9-84)

MEDICAL CENTER POLICY
MEMORANDUM NO. 115-2-86

VETERANS ADMINISTRATION MEDICAL CENTER
AUGUSTA, GEORGIA

FEBRUARY 5, 1986

SUBJECT: Procedure for All In Vivo Nuclear Medicine Studies

1. PURPOSE: The purpose of this memorandum is to establish the procedure for all in vivo Nuclear Medicine studies.

2. POLICY: The Nuclear Medicine Service is to perform all clinical in vivo patient studies involving the use of radioactive materials.

3. PROCEDURES:

   a. In the interest of safe handling and administration of radioactive materials, all patients will be injected in the Nuclear Medicine Department, unless their clinical condition otherwise mitigates. In such an event, arrangements will be made by the Nuclear Medicine Service for the proper transport of the radioactive material to the patient.

   b. All radiopharmaceuticals for clinical in vivo patient studies will be assayed immediately prior to injection by the Nuclear Medicine Service.

4. REFERENCES: VA Manual M-2, Part XX.
Medical Center Policy Memorandum No. 115-1-80 dated August 13, 1980.

5. RESCISSIONS: Medical Center Policy Memorandum No. 115-2-84 dated February 24, 1984.
This memorandum is automatically rescinded February 5, 1988.

Eugene E. Speer, Jr.

EUGENE E. SPEER, JR.
Medical Center Director

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