

Radiation Safety Handbook

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1.0 REVISION STATUS

This section will show what revisions have been made to the **Radiation Safety Handbook**. It will list the section number, give a brief description of the change or addition, and list the effective date.

Date -----	Section -----	Revision -----
05/20/86	Entire Document	Handbook revised for Policy Display System
10/07/86	Entire Document	Minor wording additions and deletions and change of name to Radiation Safety Committee from Radioisotope Committee
	Sec. 4.7.2	Additional information about rinse and decontamination water
	Sec. 4.7.4	Change in disposal of long-lived liquids
	Sec. 4.10.2	Change in violation notices and penalties

2.0 EMERGENCY PROCEDURES

The following emergency procedures will always be carried out immediately. Additional steps to take for a specific type of emergency are in a following section.

1. During normal working hours, call the Radiation Safety Office (5364). Someone in the office will contact other emergency agencies as needed, or will advise as to whom to call.
2. If the emergency occurs after normal working hours, call the Va Tech Police Department (6411) and tell the dispatcher there is a radiation emergency. The dispatcher will notify Radiation Safety personnel according to a priority list.
3. Va Tech Police officers will go to the scene of the emergency with the Radiation Emergency Kit assigned to them. They will, under the guidance of Radiation Safety personnel, provide such assistance as required to protect the public, and allow efficient corrective actions to be taken.
4. The following University officials shall be notified after steps have been taken to obtain emergency assistance by person in charge on the scene.
 - a. Head of Health & Safety Department:
Dr. A. Keith Furr (office - 6775,
home - 552-2250).

- b. Radiation Emergency Physician (if appropriate class of emergency):
Dr. R. F. Desjardins (office - 6444, home - 951-3466).
- c. Department Head
- d. Building Warden (when needed)
- e. Other University officials will be notified by the above, as considered appropriate.

A full report on all emergencies will be made available to the Radiation Safety Committee promptly so it can be determined what corrective and/or disciplinary measures are needed.

2.1 POSTING EMERGENCY PROCEDURES

The emergency telephone numbers and laboratory line of authority should be given to everyone who works in the lab. The same information should be posted next to every telephone in the lab.

The information in Figure 1 is to be posted outside the entrance to all laboratories containing radioactive materials.

EMERGENCY PROCEDURES AND CONTACT PERSONS
PERSONNEL PROTECTION ALWAYS TAKES PRIORITY

During normal working hours, call the Radiation Safety Office, which will contact other emergency agencies as needed, or will advise as to whom to call.

If the emergency occurs after normal working hours, call the Va Tech Police Department and tell the dispatcher there is a radiation emergency.

Emergency Telephone Numbers	8 am - 5 pm	After 5 pm
Radiation Safety Office	5364	6411
Va Tech Police Department	6411	6411
Rescue Squad (Va Tech)	9-911	9-911
Fire (Blacksburg)	9-911	9-911

The following University officials shall be notified after steps have been taken to obtain emergency assistance by person in charge on the scene.

	Office	Home
Head of Health & Safety Department, Dr. A. Keith Furr	6775	552-2250
Radiation Emergency Physician (If appropriate class of emergency) Dr. R. F. Desjardins	6444	951-3466
Head, Department of _____ Name _____	_____	_____
Building Warden (when needed) _____	_____	_____

In an emergency, the highest available person on this list shall be notified, to help as needed.

	NAME	TELEPHONE	
		Office	Home
Laboratory Authority	_____	_____	_____
(Other Principal Users)	_____	_____	_____
(Staff)	_____	_____	_____
(Students)	_____	_____	_____

Figure 1. Emergency Procedures To Be Posted

2.2 CLASSES OF RADIATION EMERGENCIES

Radiation emergencies will be classified in one of the following categories.

1. Exposure above legal limits, or contamination of personnel.
2. Fire or explosions involving radioactive material, or in an area where this could occur.
3. The threat of an explosion or fire leading to the potential for dispersion of radioactive material outside the designated use area.
4. Spills involving radioactive material.

2.3 ACTION FOR EACH CLASS OF RADIATION EMERGENCY

1. Exposure or contamination accompanied by injury to personnel.

The Radiation Safety Office, Va Tech Police, the Va Tech Rescue Squad, the Radiation Emergency Physician and the Laboratory Authority are to be notified.

A plan has been developed with Montgomery County Hospital to handle this class of emergency. In the event the resources of the local hospital are not sufficient, the injured personnel are to be transported to the medical facility at Oak Ridge National Laboratory by the most rapid transportation available. At least one Radiation Safety person will accompany the medical personnel.

Immediate information to be provided to emergency personnel will include, if possible, type and form of radioactive material, radiation levels or activity, any non-radiation related hazards, etc.

2. Exposure above legal limits or contamination of personnel (greater than 220 dpm).

Notify the Radiation Safety Office, which will advise of immediate emergency actions needed, and will initiate an immediate review of the circumstances of the incident.

For personnel contamination, normally an unaffected person should do the reporting.

The contaminated individual should remove any contaminated clothing and go to the nearest shower (normally available within the laboratory), and thoroughly wash the contaminated portions of his body. If only a limited portion of the body is involved, washing in a sink will be sufficient.

The area should be secured, and steps taken to prevent the further spread of radioactivity. An informed person should remain in the area to assist emergency response personnel.

3. Fire or explosion involving radioactive materials or in an area where this could occur.

If a fire or an explosion directly involves radioactive material, the area should immediately be evacuated and the Fire Department notified.

Each building at the University has an emergency evacuation plan and a person designated as the Building Warden, who is responsible for carrying out the plan. This person is to be notified if an evacuation is necessary.

The Radiation Safety Office and the Laboratory Authority should be notified.

The Fire Department will, under the guidance of Radiation Safety personnel, take steps to put out or contain the fire. Informed persons shall re-

main at the scene to assist the emergency response personnel.

If the fire or explosion does not immediately involve radioactive material, and it is possible to do so, laboratory personnel should attempt to put out a small fire (e.g. in a wastebasket), or remove radioactive material to a safer location. If it is not possible to take immediate corrective actions, notify the authorities as above and assist them in minimizing the dispersal of radioactive material.

4. Threat of a fire or explosion

The most likely event of this type would be a bomb threat. In such a case immediately call the Va Tech Police and tell the dispatcher of the potential radiation hazard.

The dispatcher will notify the Radiation Safety office and other appropriate University Officials.

If a bomb threat is involved, as by a telephone call, the person receiving the call should try to obtain as much information as possible to assist the police in identifying the caller and the circumstances of the threat.

5. Spills involving radioactive material

- Minor Spills: Small localized area, no alpha activity and no activity greater than 10,000 dpm.

Restrict access to the contaminated area and notify the Radiation Safety Office. The area will be decontaminated under supervision of Radiation Safety personnel.

- Major Spills:

For other than minor spills, involving high radiation levels or posing the likelihood of airborne contamination, immediately turn off any ventilation units in the area.

Evacuate and secure the area. When an evacuation is needed, notify the Building Warden, who will carry out the emergency evacuation plan for the building.

Notify the Radiation Safety Office, Va Tech Police and the Laboratory Authority.

If the possibility of spreading contamination exists, prevent personnel from having access to the area until emergency units arrive. Decontamination efforts will be under the guidance and supervision of radiation safety personnel.

Before making the area available for use, the Radiation Safety Office will monitor the area and certify in writing that radiation limits are within limits in 10 CFR Part 20.

3.0 RADIATION SAFETY - ORGANIZATION

All radiation safety matters are to be reported to the Vice-President for Administration and Operations, under whom are the University Department of Health and Safety (DHS) and the University Radiation Safety Committee. The Radiation Safety Committee is the final authority in all radiation safety matters. The Department of Health and Safety administers the University radiation safety policies on a daily basis, through its Radiation Safety Office division.

3.1 RADIATION SAFETY COMMITTEE

The Virginia Tech Radiation Safety Committee (RSC) has been established by the University as a University Operational Committee with the authority to regulate the safe use of ionizing and non-ionizing radiation by University personnel. It shall develop rules and regulations for this purpose and oversee their implementation.

Members of the Committee are appointed by the Vice-President for Administration and Operations. The head of the Department of Health and Safety, the Radiation Safety Officer responsible for the use of radioisotopes, and the Radiation Safety Officer responsible for X-rays shall be ex-officio members. A representative of the Purchasing Department serves as a member to provide guidance in business and financial matters.

At least two active users of radioisotopes, one user of X-rays, and other members, as necessary, are appointed by the Vice President for Administration and Operations on the basis of their experience with radiation.

An individual with administrative experience and responsibilities serves as Chairman of the Committee. Members of the

Committee shall serve for 3-year terms and may be reappointed for more than one term.

A member who misses three consecutive meetings without approval of the chairman for adequate cause shall be considered to have resigned.

A meeting of the committee will be held at least quarterly. Additional meetings shall be called by the chairman when necessary. Minutes of the meetings shall be recorded and distributed to selected persons. A quorum shall consist of half of the members plus one. Decisions shall be upon approval of a majority of the members present. In the event of a tie, the Chairman may vote.

The Radiation Safety Committee shall approve all applications for use of radiation devices and radioactive material by University personnel. It shall monitor the operations of the users of these materials and equipment. Any modifications or improvements it considers necessary in the interest of radiation safety or compliance with federal, state, or internal regulations shall be affected at the shortest possible interval.

The committee may delegate authority to the chairman (or whomever the chairman designates in writing as an alternate), and to a Radiation Safety Officer. The delegates would have the authority to act in the committee's behalf on such occasions that arise between normal meeting dates that do not warrant a special meeting of the full committee. An example of this would be the approval of the addition or deletion of a radioisotope for use in an individual laboratory.

In case of noncompliance with the codes set forth in this manual, the Committee has the authority to take such actions as specified in the Disciplinary Procedures section of this manual. For the administration of disciplinary actions, an ad hoc disciplinary subcommittee will be established. The

membership of the subcommittee will be selected and led by the Chairman of the Radiation Safety Committee, unless the Chairman designates an alternate in writing to avoid a potential conflict of interest. Those selected will include the appropriate Radiation Safety Officer and individuals with experience relevant to the incident. The selected individuals can be from outside the Committee.

"New experiments," which differ in size, kind and/or scope from previous experiments, shall be submitted to the Committee in writing and approved before the experiment can be performed. The documentation of new experiments, which shall be reviewed and approved by the Radiation Safety Officer or his alternate (designated in writing), shall include:

- the purpose of the experiment,
- a description of the experiment, and
- an analysis of the possible radiation produced by the experiment and the hazards associated with the performance of the experiment.

3.2 DEPARTMENT OF HEALTH AND SAFETY

The Department of Health and Safety (DHS) is charged with the responsibility for the coordination of all safety and environmental safety programs at the University not specifically assigned elsewhere, such as police or student health services. Radiation Safety is a division of this department.

The Head of the DHS supervises the work of the University's Radiation Safety Officers to assure that the policies in this manual; the applicable federal, state, and internal regulations; and the decisions of the Radiation Safety Committee are carried out.

3.3 RADIATION SAFETY OFFICERS

The Radiation Safety Officers are staff members of DHS, who by reason of education, training, and experience, are qualified to advise others in the safe use of ionizing radiation and to supervise the health physics program of the University. The Radiation Safety Officers, with the assistance of their staff, shall discharge the duties that are summarized below:

- These persons shall act in supervisory capacities in all aspects of the University's radiation measurement and protection activities. This includes responsibility for personnel monitoring, training, maintenance of exposure records, radioactive material inventories, survey methods, waste disposal and inspections to assure compliance with radiological safety practices. These practices are specified in Nuclear Regulatory Commission licenses and regulations, in this manual, and in the Reactor Procedures Manual, or are developed and approved by the Radiation Safety Committee.
- A Radiation Safety Officer's written approval is necessary for all activities and procedures that involve actual or potential exposure of personnel to radiation or the release of radioactive materials to the environment. Where such activities are not covered by established procedures, these persons shall bring these activities before the Committee.
- The Radiation Safety Officers shall be available to consult with all users of ionizing radiation and give advice in radiological safety practices.
- The officers shall suspend any operation causing, or believed capable of causing, an excessive radiation hazard as rapidly as possible. Violations will be treated according to the Disciplinary Procedures Section of this manual.

- The officers shall perform routine and special radiation surveys as considered necessary in the interest of radiation safety.
- The Radioisotope Radiation Safety Officer shall prepare a quarterly resume of incidents, inspections, material received, and an inventory of radioactive material on campus for the Committee. This person shall maintain a list of authorized users of radioisotopes or ionizing radiation and shall furnish a copy of this list to the Radiation Safety Committee at each quarterly meeting.
- The Reactor Radiation Safety Officer shall prepare a quarterly health physics report covering the Nuclear Research Laboratories. The report will include a list of material received and transferred, a summary of exposures, and any abnormal occurrences.
- The X-ray Radiation Safety Officer shall prepare a quarterly health physics report covering the University's X-ray laboratories. The report will include a summary of exposures, a current list of authorized users, and any abnormal occurrences.

4.0 HEALTH PHYSICS PROCEDURES

Health physics procedures are established by the Radiation Safety Committee to be followed by all persons working with radioactive materials.

The following rules shall be prominently posted in each laboratory.

GENERAL LABORATORY RADIOLOGICAL SAFETY RULES AND PROCEDURES

1. High standards of cleanliness and good housekeeping must be maintained in all laboratories where radioactive material is present.
 2. One or more preliminary runs using appropriate test materials are recommended for new procedures and new personnel to test effectiveness of procedures and equipment.
 3. Eating, drinking, and smoking are not permitted in laboratories or rooms where radioactive materials are used or stored.
 4. All injuries possibly involving radioactive material, no matter how slight, shall be monitored by Radiation Safety personnel to determine if the wound is contaminated. Special protection is required for wounds to prevent the entry of radioactive materials into the body through wounds. Each situation shall be evaluated on its merits by Radiation Safety personnel.
 5. All equipment that is suspected to have come in contact with loose radioactive material shall be considered potentially contaminated. The equipment shall be monitored for contamination by an authorized user before being removed from the laboratory.
- Contamination can be minimized by performing work on surfaces protected by plastic-backed absorbent paper.
6. All persons who have been designated to wear personnel monitoring equipment by the Radiation Safety Officer shall always wear such devices when they work with or near radioactive materials.
 7. All persons who are permitted to work with radioactive materials shall be fully aware of the procedures specified in this manual, and be instructed in matters of radiological safety. The Radiation Safety Handbook is available on the Va Tech Policy Display System for review by anyone with access to a computer terminal. It is the responsibility of the Laboratory Authority (who shall be a Principal User of radioactive material) to ensure that all personnel in his area be made fully aware of the contents.
 8. All containers for radioactive material shall be properly labeled in conformance with the standards required in Title 10, Code of Federal Regulations, Part 20 (10 CFR Part 20), regulations of the Commonwealth of Virginia, and of the University.
 9. Radioactive solutions shall not be pipetted by mouth.
 10. Protective clothing and other personnel protective equipment, such as goggles and respirators appropriate to the conditions, shall always be worn when working with loose radioactive materials. In all such cases, as a minimum, gloves shall be required.
 11. Radioisotopes shall be used in such a manner that radiation exposure rates to personnel shall be kept as small as possible. The use of appropriately designed shields will serve to minimize exposure. Work with volatile materials must be performed in a hood meeting specifications for radioisotope use.

12. Remote equipment (long-handled tongs, remote pipettes, etc.) shall be used routinely when handling highly radioactive materials.
13. Cleaning personnel shall clean only areas designated by the Laboratory Authority. The users or their qualified laboratory personnel shall be responsible for the rest of the housecleaning.
14. When use of a facility or storage area is to be terminated, the Radiation Safety Office is to be notified. Its personnel shall make a terminal survey before releasing the area for other uses.

4.1 FACILITIES

Appropriate laboratory facilities must be available to all users of radioactive materials as described in this section. Each separate laboratory facility shall have an individual designated as the Laboratory Authority (person in charge), as defined in the section on obtaining Authorization to Use Radioactive Material.

• Ventilation

Adequate ventilation must be provided, equivalent to that needed for chemical operations. The University has established 6 air changes per hour as the standard in the absence of specific regulatory rules governing a given operation.

• Storage

All radioactive material under the control of a specific Authorized Principal User must be stored in a secure, lockable storage area. If more than one user shares a common facility, all radioactive material belonging to each user shall be segregated in such a way that no accidental transfer of material can occur. Radioactive waste storage

areas shall be established to permit conformance with the radioactive waste procedures described in the Radioactive Waste Disposal Section.

• Work Areas

Work areas shall be defined within each laboratory. As much work with radioisotopes as possible shall be done in the work area. If the radioactive material is used in a volatile form, or in such a way that aerosols containing radioactive material could be readily dispersed, the work must be performed to minimize the airborne contamination.

• Fume Hoods

As much work as possible in a laboratory should be done in a radioisotope-rated fume hood. Specifications for these hoods are as follows:

1. The hoods should be designated as a Radioisotope Fume Hood by the vendor.
2. The interior should be one-piece, seamless material, with coved corners free of joints, cracks or gaskets. The preferred material is stainless steel.
3. Ducts will be stainless steel. Each hood shall be ducted independently, directly to the roof.
4. Blowers shall be roof-mounted, spark-proof, explosion-proof units, sized by the Physical Plant Department. Minimum flow shall be 100 feet per minute (fpm) and maximum flow shall be 150 fpm at permissible sash openings.
5. A HEPA filter shall be used in the exhaust duct if the unit is to be heavily used for radioisotope work.
6. New units are to have an air motion sensor and alarm to ensure proper

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air velocity and direction. Older units shall have, as a minimum, a signal light to show that the motor is receiving power.

7. It is recommended that the sash opening be minimized (less than 18 inches). Any equipment in the hood and work done in the hood should be as far from the opening as possible. These factors have been shown to have a major influence on reducing spillage from the hood, up to 2 orders of magnitude.
8. Location of the hoods within a facility must be done in cooperation with DHS and Physical Plant personnel. Hoods shall be located as much as possible in a draft-free, low-traffic area. It should not be necessary to pass a hood to escape from an area in case of fire, an accident involving radioactive contamination or other emergency.
9. When there is maintenance on the hood, a check for contamination

must be done before any work is done. DHS personnel must certify the hood is working properly before it is returned to service.

• Other

Except where this manual preempts other University safety regulations, such as the Laboratory Safety Manual, Animal Care Facility Regulations, etc., facilities for the use of radioactive material shall conform to all of these other standards.

4.2 LIMITS OF EXPOSURE TO IONIZING RADIATION

No person shall be permitted to receive a radiation dose in one calendar quarter above those listed in this paragraph, except under the conditions specified in the following paragraph. The exposure limits, in rems per calendar quarter, are shown in Figure 2.

1. Whole body, including head and trunk; active blood-forming organs; lens of the eye; or gonads 1.25
2. Hands and forearms; feet and ankles 18.75
3. Skin of whole body 7.5

Figure 2. Exposure Limits (Rems per Quarter)

An individual may receive a radiation dose above those listed above, provided the following conditions are fulfilled:

1. During any calendar quarter, the dose to the whole body (as defined above) shall not exceed 3 rems; and
2. The total dose to the whole body during the calendar year shall not exceed 5 rems; and

3. The exposure is approved by the Radiation Safety Office based on consideration of appropriate records of previous radiation exposure.

An individual under the age of 18 years will never be permitted to receive a radiation dose greater than 10 percent of the limits set forth above.

No individual in a restricted area shall be exposed to airborne radioactive material in concentrations above those specified in Appendix B, Table 1 of 10 CFR Part 20. These limits are specified for an exposure of 40 hours in any seven consecutive days. If the individual's exposure is for a period other than 40 hours, the limiting concentrations should be adjusted proportionally. These concentration limits may not be altered by using respiratory protection or particle size determinations, except as specifically authorized by 10 CFR Part 20.

Women, whether employees or students, shall restrict their radiation exposures according to the guidelines established in Regulatory Guide 8.13, "Possible Health Risks To Children Of Women Who Are Exposed To Radiation During Pregnancy." The recommended limit for women during a pregnancy is 500 millirem per year.

4.3 MARKING AND LABELING

Rooms, areas, and equipment where radioactive materials are used or stored shall be clearly marked with appropriately worded and designated standard radiation signs, as defined by 10 CFR Part 20.203, whenever required under the conditions set forth in that section. Some of the more commonly applicable provisions are given below.

- Each area or room where radioactive materials are used or stored (except natural uranium or thorium) in quantities above 10 times the quantities listed in Appendix C of 10 CFR Part 20 (or 100 times the quantities listed if natural uranium and thorium are used), shall be posted with the standard sign and the words: CAUTION - RADIOACTIVE MATERIALS.

Exceptions to this rule are in cases where:

1. The radioactive material is a sealed source, so the radiation

level at 12 inches from the surface of the source container does not exceed 5 millirem per hour.

2. The radioactive material is used in a RESTRICTED AREA and:

- is in use for less than 8 hours, and
- is constantly attended during the period by a person trained in radiation safety.

A Restricted Area is any area where access is controlled by Va Tech to protect individuals from exposure to radiation and radioactive materials. Residential quarters cannot be included in a Restricted Area.

- Each container in which radioactive material is used, stored, or transported shall be labeled with:

- the radiation symbol,
- the words: CAUTION - RADIOACTIVE MATERIALS, and
- the isotope, quantity, and date of measurement (if the quantity involved exceeds those listed in Appendix C of 10 CFR Part 20).

Exceptions to this rule are in cases where:

1. The concentration of the material in the container does not exceed the limits specified in Appendix B, Table 1, Column 2 of 10 CFR Part 20.
2. The containers are used intermittently in lab work with the user present.

- A Radiation Area is any area accessible to personnel where there exists radiation at such levels that a major portion of the body could receive:

- in any one hour a dose over 5 millirem, or
- in any 5 consecutive days a dose over 100 millirem.

Each such area shall be clearly marked with a standard radiation sign bearing the words: CAUTION - RADIATION AREA.

- A High Radiation Area is any area accessible to personnel where there exists radiation at such levels that a major portion of the body could receive:

- in any one hour a dose over 100 millirems.

Each such area shall be clearly marked with a standard radiation sign with the words: CAUTION - HIGH RADIATION AREA. The area shall meet additional requirements specified in Part 20.203 for areas existing for more than 30 days.

• An Airborne Radiation Area is any area that fits the following definition:

1. Any room, enclosure, or operating area where airborne radioactive materials exist in concentrations above the amounts specified in Appendix B, Table 1, Column 1 of Part 20; or
2. Any room, enclosure, or operating area where airborne radioactive material exists in concentrations that, averaged over the number of hours in any week when individuals are in the area, exceed 25 percent of the amounts specified in Appendix B, Table 1, Column 1 of Part 20.

Any such area shall be clearly labeled with a standard radiation sign with the words: CAUTION - AIRBORNE RADIOACTIVITY AREA.

4.4 PERSONNEL MONITORING

A person shall wear a monitoring device if he enters an area where he may receive a dose of 25% or over the exposure limits in "Limits of Exposure to Ionizing Radiation".

The monitoring devices will be a film badge, or a thermoluminescent dosimeter (TLD), and/or a pocket dosimeter, unless other devices are authorized by the Radiation Safety Officer.

The Radiation Safety Officer will supervise obtaining, distributing, and collecting personnel monitoring devices.

When film badges are used, the film shall be changed on a monthly basis, or periodically as determined by the Radiation Safety Committee.

When a TLD is used, the badge will be processed:

1. On a monthly basis (or as determined by the Radiation Safety Committee) where significant exposures are possible, or
2. On a quarterly basis where exposures are expected to be low.

Pocket dosimeters shall be worn when indeterminate levels of radiation are suspected, or as determined by Radiation Safety personnel.

If an exposure over the limits is suspected to have occurred, the Radiation Safety Officer is to be notified immediately, so the monitoring device may be processed for rapid analysis.

The Senior Principal User is to notify the Radiation Safety Officer whenever he believes an individual will require personnel monitoring and whenever the need for personnel monitoring is terminated. The Personnel Monitoring Request and Training Record Form (RSO-1) should be used. However, the Radiation Safety Officer shall

make the determination of whether a personnel monitoring device is needed. Normally, users of radioisotopes other than Tritium and C-14 will require dosimeters.

When not in use, personnel monitoring devices shall be stored in areas where they will not be exposed to ionizing radiation. AT NO TIME WILL A PERSONNEL MONITORING BADGE BE DELIBERATELY EXPOSED TO RADIATION UNLESS IT IS WORN BY THE EXPERIMENTER OR UNLESS THE RSO APPROVES. The badges will not be worn during non-occupational exposure, such as medical X-rays.

All personnel monitoring records will be maintained by the Radiation Safety Officer. If applicants have a prior record of radiation exposure, they must provide this data for inclusion in the Va Tech records.

4.5 BIOASSAY

All persons routinely exposed to open sources of radioactive materials in quantities exceeding 20 times the investigation levels listed in ICRP publication 10 (or calculated where a limit has not been listed therein), will be required to have a routine bioassay performed before and after an experiment. See Appendix A for list of Action Levels (Action Level = 20 times the investigation levels).

An experiment may consist of a series of operations extending over a considerable number of working days. If an experiment continues beyond a calendar quarter, bioassays will be performed quarterly until the conclusion of the experiment.

Analysis of the thyroid area will be by external measurements with a suitable monitoring instrument. Other bioassays will routinely consist of urinalysis for gross beta minus potassium (K-40), performed by a commercial laboratory.

Bioassays will also be performed if there is an accident or an unusual experiment involving a known or suspected hazardous

condition. Such an experiment would require prior approval of the Radiation Safety Committee.

If the evaluation of a urine sample exceeds 3 times the minimum sensitivity of the commercial laboratory's counting system, the following actions will be taken:

1. Resample for reevaluation and identification by the commercial firm.
2. Perform locally either a gamma scan or a liquid scintillation measurement to identify the material.
3. After identification, follow the biological elimination until a positive result is no longer obtained.
4. If a body burden is approached, outside advice and assistance will be solicited, such as from the ORNL Emergency Response Group.

4.6 CONTAMINATION, RADIATION MONITORING AND CONTROL

The contamination monitoring and control program will consist of the following:

1. In laboratories where an unsealed source of radioactive material was actively used, a loose surface contamination survey of the work area will be conducted at the end of each work day, or at the completion of work with the radioactive material that day.
2. In laboratories actively using unsealed sources of radioactive material, a weekly loose surface contamination survey of the entire laboratory and unrestricted area adjacent to the exit points will be conducted.
3. If the limits defined in this section are exceeded, then the Radiation Safety Officer shall be notified.

Note: The method used in monitoring is left to the discretion of the Laboratory Authority, if the method provides the necessary sensitivity to maintain the prescribed limits. The recommended method is by the filter paper swipe technique. Beta-Gamma instruments may be used only if conversion factors are calculated and attached to the instrument.

Laboratories actively using tritium alone will conduct a loose surface contamination survey at least once a week.

4. Limits

Limits for contamination are necessary to ensure the safe handling of radioactive material. The limits are dependent on whether the areas are restricted or unrestricted. Appendix C presents the various fixed and loose contamination limits.

Laboratories where higher-energy radioactive materials (e.g., P-32, Co-60, I-131) are used or stored shall, in addition to the above, be equipped with suitable portable radiation-detecting instruments. Laboratories with continued or long-range operations shall provide the instruments as approved by the Radiation Safety Officer. Laboratory personnel shall use these instruments daily, or more frequently when operational changes are made so as to detect any radiation hazards.

ALL SURVEY RESULTS SHALL BE MAINTAINED IN A PERMANENT LOG.

Instruments will be calibrated against known standards, e.g., Cs-137 and Co-60 of known specific activities. Preventive maintenance and battery checks shall be performed, before the radiation calibration, as required by the technical manuals. It is the responsibility of the Senior Principal User to ensure that these checks are completed before delivery to the Radiation Safety Office for calibration. Source calibrations are to be performed at

no more than 6-month intervals, or earlier after any maintenance affecting the calibration.

Calibrations are performed with the source at two different distances from the instruments with readings taken on appropriate instrument ranges.

If the spread of radioactive contamination is suspected by laboratory personnel, ALL WORK SHALL BE SUSPENDED IMMEDIATELY. The procedures outlined in Section 1 shall be followed for reporting and decontamination of the area. Personnel shall remain available to the Radiation Safety Office.

At least annually, or more often as considered advisable, Radiation Safety Officers shall conduct an unannounced inspection of each laboratory, which will include a review of the condition of the facility, a review of the survey logs and the radioactive material inventory. Swipes shall be made when appropriate.

Recommendations will be made, in writing, to the Laboratory Authority, who will respond to the recommendations and acknowledge he has read the report by signing it.

It will be the responsibility of the Laboratory Authority to carry out the recommendations as soon as possible, but never later than 90 days without the explicit approval of the Radiation Safety Committee.

4.7 RADIOACTIVE WASTE DISPOSAL PROCEDURE

4.7.1 Waste Categories

Radioactive wastes generally include isotopes with a short half-life (less than 15 days; e.g. P-32 and Ca-47); an intermediate half-life (15 - 65 days; e.g. P-33, Cr-51, Fe-59, Hg-203 and I-125); and a long half-life (65 days or longer; e.g. C-14, H-3, S-35, Ca-45, Mn-54 and Zn-65).

Types of radioactive waste include dry solids, liquids, and animal carcasses.

Dry solid waste is primarily composed of paper, plastic or glass that become contaminated during work with isotopes. No free liquid is allowed in this type of waste.

Both aqueous and nonaqueous liquid wastes are generated. These liquids are used in conjunction with the experimental protocols. Liquid scintillation fluids constitute the major portion of nonaqueous liquids being generated because of the need to analyze samples.

Animal carcasses comprise the last type of radioactive waste. They are generated because some experimental protocols require that animals be administered isotopes.

4.7.2 Collection of Waste By Laboratory Personnel

Waste must be segregated into the following groups based on half-life: short, intermediate and long-lived.

All receptacles and packages containing waste must be labelled "Caution - Radioactive Material."

Dry Solid:

- Waste is collected only in plastic-lined 5-gallon, 20-gallon or 55-gallon containers provided by the Radiation Safety Office.
- Prior to removal from the laboratory, activity estimates must be determined for each isotope in the container. The estimates should be as exact as possible.

Liquids:

- Bulk liquids are collected in 1-gallon or 5-gallon containers. Most plastic or glass bottles are approved for

storage of liquid waste, except plastic milk jugs. Aqueous liquid must be segregated from nonaqueous liquid. Aqueous liquids containing H-3 or C-14 must be segregated from all other aqueous liquids in order to simplify sink disposal by the RSO.

- Prior to removal from the laboratory, activity determinations for each isotope in the container must be made. In order to determine activities, analyze aliquots of each container and convert to total container activity in uCi.
- Liquid scintillation vials are to be collected upright if possible. Collect in trays, plastic-lined boxes or 55-gallon drums. The vials must be segregated according to specific activity. Specific activities less than 0.05 uCi/ml must be separate from all others. Additionally, H-3 and C-14 less than 0.05 uCi/ml must be kept separate from any other isotopes because of less-expensive disposal methods.
- Prior to removal from the laboratory, activity estimates must be determined for each isotope in the container. When feasible, exact counts on vials can be totaled and converted to uCi.
- All original solutions and first rinses must be collected as waste. Other rinses or equipment decontamination water can be released into the sanitary system if:
 1. the liquid is readily soluble or dispersible in water,
 2. the total release is not greater than 1 uCi per day, and
 3. the release is flushed with copious amounts of water.

Animal Carcasses:

- Carcasses are collected in plastic bags or plastic containers. They must be

maintained frozen until they are removed. Carcasses must be segregated according to specific activity. Specific activities less than 0.05 uCi/g must be separate from all others. Additionally, H-3 and C-14 less than 0.05 uCi/g must be kept separate from any other isotopes to allow for incineration by the RSO.

- Prior to removal from the laboratory, activity determinations must be made. Since specific activity is known, the weight of the carcass is multiplied by the specific activity to yield the total activity in uCi.

4.7.3 Waste Removal From Laboratories

Radiation Safety personnel remove waste from laboratories every 3 months. Removals on an interim basis can be arranged as necessary.

Prior to removal from a laboratory, each box or container must be properly labelled with a 'Radioactive Waste' label. This will identify:

- the senior user,
- the isotope(s),
- the activity corrected for decay, and
- the waste type.

No more than one waste type can be marked on each label.

4.7.4 Waste Packaging By Radiation Safety Personnel

Short- and Intermediate-Lived Waste (less than 65 days)

- Dry Solid:

Plastic liner is placed in a 55-gallon drum. After the drum is filled with waste, the bag is twisted shut and se-

cured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. The drum is then numbered with an indelible marker.

- Liquids:

Bulk liquids are packed using a plastic-lined 55-gallon drum. After 6 inches of vermiculite are added, approximately six jugs of waste are placed in the drum. Vermiculite is added until 2 inches above the layer of jugs. One more layer of jugs is placed in the drum with vermiculite added as before. The plastic liner is twisted shut and secured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. The drum is numbered with an indelible marker.

Liquid scintillation fluids are not held for decay due to their hazardous chemical composition. They are handled the same way as scintillation fluid containing isotopes with long half-lives.

- Animal Carcasses:

Carcasses are not packaged in drums because of biological degradation. They are maintained frozen until 10 half-lives have elapsed.

Long-Lived Waste (65 days or longer)

- Dry Solid:

Dry waste is packed in a plastic-lined 55-gallon drum. Compactible waste is packed separately from noncompactible waste. Once the drum is full, the plastic liner is twisted shut and secured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. The drum is numbered with an indelible marker.

- Liquids:

Bulk aqueous liquids primarily containing H-3 and C-14 are released into the sanitary system every 3 months.

The magnitude of the release is contingent upon adherence to the regulations in 10 CFR 20.

Any bulk liquids not released to the sanitary system are packed in 55 gallon drums. Several inches of vermiculite are put in the bottom of the drum. A plastic liner is put into the drum and 6 inches of vermiculite is added. Approximately six jugs of waste are placed in the drum. Vermiculite is added around and to several inches above the top of the jugs. One more layer of jugs is placed in the drum and covered with vermiculite. No more than 15 gallons of liquid are allowed per drum.

Once the drum is filled with jugs and vermiculite, the plastic liner is twisted shut and secured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. The drum is numbered with an indelible marker.

Liquid scintillation fluid in vials is packaged according to the specific activity of the fluid and the half life of the isotopes. Specific activities less than 0.05 uCi/ml of H-3 and C-14 are to be segregated from all other isotopes. Vials containing isotopes with half lives less than 70 days are to be segregated from all other types.

These three types of fluid in vials are packaged identically. Six inches of vermiculite are added to a plastic-lined 55-gallon drum. A second liner is put in the drum, followed by the addition of vials until the drum is full. Each plastic liner is twisted shut and secured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. The drum is numbered with an indelible marker.

- Animal Carcasses:

Specific activity also determines the disposal method for animal carcasses. Those with less than 0.05 uCi/g of H-3 or C-14 can be incinerated. Carcasses

containing 0.05 uCi/g or greater of H-3 or C-14 and any other isotopes must be packaged.

For carcasses that are packaged, a plastic-lined 30-gallon drum has 6 inches of vermiculite and lime (10 parts to 1 part) added. This mixture is used to retard biological degradation. Then alternate layers of carcasses and vermiculite/lime are added until the drum is full. The plastic liner is twisted shut and secured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. This drum is placed inside a 55-gallon drum, with vermiculite added to fill the void spaces. A gasketed lid is bolted onto the drum with a closure ring. The drum is numbered with an indelible marker.

4.7.5 Final Disposition Of Waste

- Short- and Intermediate-Lived Waste:

Drums are surveyed for radiation using GM or ion-chamber portable survey instruments. Contamination surveys are performed with filter paper swipes and analyzed in a liquid scintillation counter. The drums are labelled in accordance with DOT regulations and manifested. Then they are transported to the Waste Storage Building and stored for 10 half-lives.

After this decay period, the waste is surveyed with a frisker to ensure that the waste has reached background levels. During the survey process, any "Caution - Radioactive Material" labels present are removed from the waste. The cleared waste is disposed of according to type:

- dry solids to the landfill,
- liquids to the sanitary system, and
- carcasses to the incinerator.

- Long-Lived Waste:

Drums are surveyed for radiation and contamination levels as in the previous section. They are labelled in accordance with DOT regulations and manifested. Then the drums are transported to the Waste Storage Building to await removal by a commercial firm. When approximately 30 drums are ready for shipment, a radioactive waste broker is contacted to arrange for final removal from the University.

4.7.6 Records

Records of waste removal from laboratories are retained permanently by the individual laboratories until the RSO can microfilm these records. Surveys, manifests and all other disposal records are maintained by the Radiation Safety Office.

4.3 CLASSIFICATION OF RADIOACTIVE MATERIAL USERS

- Laboratory Authority

The individual designated to be the person in charge of a given area or facility. This person must be a qualified Principal User.

- Principal User

A permanent faculty or staff member approved by the Radiation Safety Committee. More than one faculty or staff member may be a principal user on a single authorization.

The first person listed on the authorization will be designated the Senior Principal User and is the individual primarily responsible for the safe use of radioactive material under that authorization.

In the extended absence of the Senior Principal User, the next Principal User present (in order of list) automatically becomes the acting Senior Principal User and assumes his responsibilities.

With approval of the Radiation Safety Committee, a research associate (faculty status), or a sufficiently experienced technician may be added to an authorization as a Principal User. However, that person may not initiate applications for an authorization to use radioisotopes.

- Participating User

A person approved by the Radiation Safety Committee to work with radioactive material under supervision of a Principal User.

4.8.1 Responsibilities

The Laboratory Authority is the person in charge of a given area or facility. Where a number of Authorizations share the use of the same facility, the Laboratory Authority has the responsibility to see that all the Senior Principal Users fulfill their own responsibilities.

The Senior Principal User has the following responsibilities to ensure the safe operation of all work with radioactive material performed under his authorization.

- Make sure that all Users under him shall comply with all applicable federal, state and University procedures and regulations when working with radioactive material.
- Be sure that all Users are familiar with the procedures of an experiment before using radioactive material.
- See that required surveys and records are maintained.

- Make sure that proper security is maintained for all radioactive material on his authorization.
- Be available on site to users, within a reasonable length of time (such as 1 hour), when radioactive material is being used and to keep all users under his authorization informed of where he may be reached. This responsibility may be delegated to other principal users, but should be in writing.
- Inform all users under his authorization of all changes to procedures and regulations as they are received by him.

Principal Users have the following responsibilities:

- To personally comply and to ensure that all participating users under their direction comply with all applicable federal, state, and University regulations.
- To maintain the ability to act as the Senior Principal User for an authorization in the event of the extended absence of this individual.

A Participating User shall perform all work with radioactive material in accordance with current federal, state, and University regulations and procedures.

4.9 AUTHORIZATION TO USE RADIOACTIVE MATERIAL

All use of radioactive material must be authorized by the Radiation Safety Committee. This section describes the method to acquire authorization to use radioactive material.

1. A person with or without previous experience desiring to use radioactive material at Virginia Tech shall complete the Radiation Safety Lecture Se-

ries and test in accordance with the section on Training.

2. An applicant to become a Senior Principal User of radioactive material shall submit a typed copy of Virginia Tech Authorization form RM-1 to the Radiation Safety Committee.
3. On receipt of the completed application, the procedures adopted by the Committee for processing it shall be carried out. As a minimum, the chairman of the committee and the Radioisotope Radiation Safety Officer will review the application for the committee. The chairman and safety officer have the authority to approve the application on an temporary basis pending final approval by the Committee.
4. The applicant will be allowed to begin operations under terms of the Authorization on receipt of a copy signed by the Radiation Safety Committee Chairman and the Radioisotope Radiation Safety Officer.
5. A copy of all approved forms will be sent to the Principal User's department head. The department head is responsible for maintaining a file on all approved authorizations in his department.

4.9.1 Amendments

Amendments to an existing Authorization must be initiated by the Senior Principal User and will be processed under the same procedures as the initial authorization request. Examples of items requiring amendments are: changes of personnel, changes in the facilities, and operational changes in the facilities affecting use of radioisotopes.

If an individual wishes to become a Principal User or Participating User on an existing Authorization, the Senior Principal

User must initiate an amendment adding the individual to his Authorization.

4.9.2 Inactive Authorizations

Any Authorization not actively used during the previous year, nor planned to be used in the immediate future, shall be automatically placed on an inactive status following the annual inspection, unless otherwise requested. The following steps must be taken when this is done:

1. An accurate current inventory of all radioactive materials on the User's Authorization is to be sent to the Radiation Safety Office. All material is to be transferred to another Authorization or to the Radiation Safety Office for storage.
2. The Radioisotope Radiation Safety Officer will make a survey of the laboratory to ensure there is no contamination of the facility above the levels permitted in the Section 4.6 for unrestricted areas.

If a Senior Principal user wishes to change to inactive status, he should send a letter to the Radioisotope Radiation Safety Office. The preceding steps will be taken to change the Authorization to inactive.

An Authorization on inactive status may be reactivated by a Senior Principal User by:

1. Submitting a letter to the Radioisotope Radiation Safety Officer requesting the reactivation, and
2. Either reviewing training tapes designated by the safety officer or participating in an oral review on current procedures with the safety officer.

4.10 DISCIPLINARY PROCEDURES

Any program that requires compliance with regulations must have a means for disciplinary actions. The following section describes the disciplinary actions applicable to the use of radioactive material.

4.10.1 Definition of Violations

Violations of the rules and regulations in this manual will be classified as follows:

- Class I - Administrative or procedural deficiency of a relatively minor nature, e.g., failure to maintain survey records properly, failure to wear a required personnel monitoring device.
- Class II - Major violations that could result in excessive radiation exposures to personnel, or willful and repeated negligence, e.g., loss of radioactive material due to negligence; improper use of ionizing radiation, materials or devices in such a way as to lead to potential injury or liability.

4.10.2 Penalties

Class I - If three citations are issued within a 1-year period, operations under an Authorization will automatically be suspended, pending a review by the Radiation Safety Disciplinary Subcommittee.

- Notice of Concern

A Notice of Concern (NOC), issued by the Radiation Safety Officer, will explain the nature of the violation and the potential for incurring further disciplinary actions. At the discretion of the Radiation Safety Officer, the NOC can be issued as a warning

or as the first citation. A copy of the NOC will be kept on file.

- First Violation

A letter of reprimand will be issued by the Chairman of the Radiation Safety Committee with a copy to the department head.

- Second Violation

An immediate cessation of operation under an Authorization will be required, normally in effect for two weeks. This action may be changed, pending a review by the Radiation Safety Disciplinary Subcommittee. A letter of reprimand will be issued by the chairman of the Committee with copies going to the department head, dean of the college involved, and the Provost.

- Third Violation

An immediate cessation of operation under an Authorization will be required, pending review of the incident by the Radiation Safety Disciplinary Subcommittee. A suspension letter will be sent by the Chairman of the Committee with copies going to the department head, dean of the college involved, the Provost, and the Vice President for Administration and Operations. After a period of one year, the Committee will review reinstatement of the Authorization.

Class II - For a Class II violation, an immediate cessation of operation under an Authorization will be required, pending review of the incident by the Radiation Safety Disciplinary Subcommittee. A suspension letter will be sent by the Chairman of the Committee with copies going to the department head, dean of the college involved, the Provost, and the Vice President for Administration and Operations.

4.10.3 Determination of Responsible Person

Citations will normally be issued to the Authorized User. However, in situations beyond the Authorized User's control, such as willful negligence by an individual, citations will be issued to the specific person responsible. This determination can be made by the Disciplinary Subcommittee, where questionable.

4.10.4 Determination of The Class of Violation

A preliminary determination of the class of violation will be made at an interim meeting of the appropriate Radiation Safety Officer and the Chairman of the Radiation Safety Committee. A review of Class I first violations will take place at the next regularly scheduled meeting of the Radiation Safety Committee. A meeting of a Disciplinary Subcommittee will be convened by the chairman as soon as practicable for Class I second and third violations and for Class II violations. The individual cited will be invited to appear before the subcommittee to assist in the determination of these classes of citations.

4.10.5 Disciplinary Actions

The Disciplinary Subcommittee will determine the appropriate action to take for all Class I violations for second and third offenses and for Class II violations. The Disciplinary Subcommittee is empowered to impose the disciplinary actions decided upon. However, the Radiation Safety Committee will review the decisions of the Subcommittee at the next regularly scheduled meeting or the chairman will call a meeting as soon as practicable upon an appeal by the individual cited. The Radiation Safety Committee may approve or modify the actions of the Disciplinary

Subcommittee as the final authority on radiation safety matters at the University.

The results of any disciplinary actions taken by the Radiation Safety Disciplinary Subcommittee, after their consideration of the incident, and of any appeals made to the Radiation Safety Committee will be sent to the same individuals to whom the original materials were sent.

4.10.6 Appeals

An individual has the right to appeal any action of the Disciplinary Subcommittee to the Radiation Safety Committee. The Chairman will call a meeting as soon as practicable.

4.11 OBTAINING RADIOACTIVE MATERIALS

The following procedure is to be followed by all persons who wish to obtain radioactive materials.

All orders for radioactive material will be originated by an authorized user (Lab Authority, Sr. Authorized User), with a Requisition for Purchase approved and signed by his department head. The authorized user will make sure his name is on the requisition.

Prior approval through the Radiation Safety Officer is necessary for any free radioactive material to be received at Virginia Tech.

The requisition is to be sent to the Radiation Safety Office for approval. All requisitions without the approval of the Radiation Safety Office will be returned to the originating department by Purchasing.

When ordering short half-life material, where time is of the essence, contact the Radioisotope Radiation Safety Officer to

make arrangements for the expeditious delivery. No phone orders will be made without a Radiation Safety Officer's approval. All orders will be placed by Purchasing or a Radiation Safety Officer.

All radioactive material will be shipped to:

Virginia Tech
Radiation Safety Office, Room 104
Health & Safety Department Bldg.
Blacksburg, Virginia 24061
Attn: User's Name

A Radiation Safety Officer will receive the shipments, perform the radiological safety survey, and notify the Authorized User that the material is ready for pick-up.

No radioactive material may be transferred unless the safety officer knows the recipient is qualified to use the material.

The procedure for receiving packages during off-duty hours is as follows:

1. During off-duty hours for radiological protection personnel, the Va Tech Police Department will accept delivery of packages containing radioactive material. Department personnel will then:
 - a. Contact the Radioisotope Radiation Safety Officer (or designated alternate) on call and inform him of the delivery. They should provide information about the contents of the package as listed on a shipping label or on the outside of the package.
 - b. They will then deposit the package in a locked storage cabinet.
2. The safety officer will retrieve the packages from the locked storage cabinet and will follow procedures to comply with the requirements of 10 CFR 20.205 (governing picking up, receiving and opening packages containing radioactive materials) and 10 CFR

Handbook subject to change. See Policy Display System.

20.105 (regulating exposure of individuals in unrestricted areas).

3. The safety officer will inform the appropriate authorized user as quickly as possible that radioactive material has been received, so the user can pick it up to avoid loss of short half-life materials.

4.12 TRANSFER OF RADIOACTIVE MATERIAL

Transfer of radioactive material on campus will be by the recommended methods of the Radioisotope Radiation Safety Officer, as approved by the Radiation Safety Committee.

Transfer of radioactive material from the campus will be done under the supervision of approved personnel from the University Radiation Safety Office.

13 TRAINING

The authorized user is responsible for assuring that all persons working under his supervision receive training in the proper use of radioactive materials at the University and in the specific laboratory.

Those individuals who have not had prior training in the use of ionizing radiation must attend a series of lectures as a minimum acceptable level of training. The content of these lectures will include:

1. Fundamentals of Radioactivity
2. Nuclear Reactions
3. Interactions of Radiation with Matter
4. Radiation Detection Instruments (theory)
5. Practical Radiation Detection Instruments

6. Federal, State and Local Regulations
7. Laboratory Design and Operations
8. Biological Effects

Persons with documented prior training must attend the lecture on topics 6 and 7 before beginning work involving radioisotopes. However, all radioisotope users will be required to pass (70% is passing) a comprehensive written test on all the material covered in the lectures.

Where additional information peculiar to an individual laboratory would be considered essential to the training of workers in a laboratory, the Radiation Safety Officer may require further documented training.

4.14 RADIOISOTOPE USE IN STUDENT INSTRUCTION

Provisions must be made to enable the safe use of radioisotopes by students under well-supervised conditions. The following steps must be taken for any use of radioisotopes by students:

1. At least 1 month before the quarter in which a class is to be taught, a basic protocol must be submitted to the Radiation Safety Office. Radiation safety training must be a part of the plan. When exempt quantities of radioactive material will be used by students, the training can be minimal. (See list of exempt quantities in Appendix B.)

However, if quantities greater than exempt will be used by any or all students, a fully documented radiation safety training session must be given.

This protocol will be routed through the Radiation Safety Committee for its concurrence.

Handbook subject to change. See Policy Display System.

2. Any professors and teaching assistants (GTA's) must be approved radioisotope users and added to the appropriate authorizations before the start of the class.
3. The locations of the laboratories must be approved and added to the appropriate authorizations.
4. A list of all students participating in the laboratory must be submitted to the Radiation Safety Office within 2 weeks after the start of the class.
5. The laboratory class should be divided into stations with two or three students at each station to avoid any confusion and to enable the lab to proceed in an orderly fashion.
6. All laboratory work with radioisotopes by students must be done under supervision by teaching assistants (approved as radioisotope users) as a minimum.

5.0 RECORDS

The following records shall be established and maintained by the Radioisotope Radiation Safety Officer:

1. Current List of Authorized Users.
2. Personnel Exposure.

The radiation exposure record of every person subject to personnel monitoring as specified in the Personnel Monitoring Section will be maintained in this file. Information specified on Form NRC-5 shall be included.

3. Radioactive Materials Inventory.

The receipt, assignment, and final disposition of all radioactive materials shall be recorded in the Radioactive Materials Inventory.

4. Radiation Survey Log.

A complete description of all radiation and contamination surveys performed by

Health Physics shall be entered in the Radiation Survey Log.

5. Air Sample Log.

The calculation and result of all air samples shall be entered in the Air Sample Log.

6. Instrument Calibration Log

The date of calibration of Health Physics survey instruments shall be recorded in the Instrument Calibration Log.

Each authorized user will maintain a running log of each radioactive isotope in his possession, to include: receipt, quantity on hand, and final disposition. An inventory will be submitted to the radioisotope Radiation Safety officer annually or when the authorized user has ended his work with radioactive materials.

Handbook subject to change. See Policy Display System.

6.0 MORE INFORMATION

If you have read through all the material, have explored all avenues and still have a question or need a policy clarified, call the contact person listed for the area you have a question about. Please have the section you have a question about displayed on your terminal when you call.

1. Douglas C. Smiley, 5364, Radioactive Materials
2. Thomas S. Smithwick, 5364, X-rays, Nonionizing Radiation
3. Dr. A. Keith Furr, 6775, Administrative Concerns

Handbook subject to change. See Policy Display System.

7.0 APPENDIX A: ACTION LEVEL QUANTITIES FOR RADIO-BIOASSAY PROGRAMS

Isotope	Action Level mCi	Isotope	Action Level mCi	Isotope	Action Level mCi
H-3	0.6	Zn-65	0.12	Ba-140	0.16
C-14	7.0	Cu-67	4.4	Ce-141	0.696
Na-22	0.26	Ga-67	14.8	Ce-144	6×10^{-3}
Na-24	4.56	Se-75	2.0	Yb-169	0.8
P-32	0.2	Br-82	0.94	Au-198	5.0
P-33	2.2	Rb-86	0.46	Po-210	4×10^{-4}
S-35	54.0	Sr-85	0.94	Ra-226	3×10^{-4}
Cl-36	1.86	Sr-89	0.08	Th-Nat.	8×10^{-7}
K-42	6.0	Sr-90	8×10^{-4}	U-233	2×10^{-4}
Ca-45	0.13	Mo-99	5.84	U-234	2×10^{-4}
Cr-51	10.96	Tc-99m	370.16	U-235	1.2 mg
Mn-54	2.96	Cd-109	0.52	U-238	1.2 mg
Fe-55	1.72	In-111	9.2	U-Nat.	1.2 mg
Co-57	19.2	I-125	0.06	Pu-239	8×10^{-7}
Fe-59	0.11	I-131	0.02	Pu-241	4×10^{-5}
Co-60	0.5	Cs-137	0.08	Am-241	8×10^{-7}
Cu-64	44.24				

Handbook subject to change. See Policy Display System.

8.0 APPENDIX B: EXEMPT QUANTITIES

Cadmium-109	10	uCi
Calcium-45	10	uCi
Carbon-14	100	uCi
Cesium-137	10	uCi
Chromium-51	1000	uCi
Cobalt-60	1	uCi
Hydrogen-3	1000	uCi
Iodine-125	1	uCi
Iodine-131	1	uCi
Iron-59	10	uCi
Manganese-54	10	uCi
Mercury-203	10	uCi
Phosphorus-32	10	uCi
Strontium-90	0.1	uCi
Sulfur-35	100	uCi
Thallium-204	10	uCi
Zinc-65	10	uCi

9.0 APPENDIX C: LOOSE AND FIXED CONTAMINATION LIMITS

Loose abbreviated as L

Fixed abbreviated as F

Unrestricted Areas:

		GROSS BETA, GAMMA	ALPHA
		-----	-----
General areas	- L	220 dpm/wipe	Non Detectable
	- F	0.05 mr/hr	Non Detectable
Skin and Personal Clothing	- L	Non Detectable	Non Detectable
	- F	0.05 mr/hr	Non Detectable

Restricted Areas:

General Areas	- L	1000 dpm/wipe	Non Detectable
	- F	1.0 mr/hr	Non Detectable
Contamination	- L	10,000 dpm/wipe	50 dpm/wipe
Control areas	- F	1.0 mr/hr	500 cpm (PAC 4G)
Anti-Contamination Clothing	-L	Non Detectable	Non Detectable
	-F	1.0 mr/hr	Non Detectable
Equipment, Tools, etc.	-L	1000 dpm/wipe	Non Detectable
	-F	1.0 mr/hr	Non Detectable

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Radioisotope Use in Student
 Instruction 4.14

Records 5.0

Revision Status 1.0

-S-

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-T-

Training 4.13

Transfer of Radioactive Material 4.12

A T T A C H M E N T I V

RADIOACTIVE WASTE DISPOSAL PROCEDURE

Note: The method used in monitoring is left to the discretion of the Laboratory Authority, if the method provides the necessary sensitivity to maintain the prescribed limits. The recommended method is by the filter paper swipe technique. Beta-Gamma instruments may be used only if conversion factors are calculated and attached to the instrument.

Laboratories actively using tritium alone will conduct a loose surface contamination survey at least once a week.

4. Limits

Limits for contamination are necessary to ensure the safe handling of radioactive material. The limits are dependent on whether the areas are restricted or unrestricted. Appendix C presents the various fixed and loose contamination limits.

Laboratories where higher-energy radioactive materials (e.g., P-32, Co-60, I-131) are used or stored shall, in addition to the above, be equipped with suitable portable radiation-detecting instruments. Laboratories with continued or long-range operations shall provide the instruments as approved by the Radiation Safety Officer. Laboratory personnel shall use these instruments daily, or more frequently when operational changes are made so as to detect any radiation hazards.

ALL SURVEY RESULTS SHALL BE MAINTAINED IN A PERMANENT LOG.

Instruments will be calibrated against known standards, e.g., Cs-137 and Co-60 of known specific activities. Preventive maintenance and battery checks shall be performed, before the radiation calibration, as required by the technical manuals. It is the responsibility of the Senior Principal User to ensure that these checks are completed before delivery to the Radiation Safety Office for calibration. Source calibrations are to be performed at

no more than 6-month intervals, or earlier after any maintenance affecting the calibration.

Calibrations are performed with the source at two different distances from the instruments with readings taken on appropriate instrument ranges.

If the spread of radioactive contamination is suspected by laboratory personnel, ALL WORK SHALL BE SUSPENDED IMMEDIATELY. The procedures outlined in Section 1 shall be followed for reporting and decontamination of the area. Personnel shall remain available to the Radiation Safety Office.

At least annually, or more often as considered advisable, Radiation Safety Officers shall conduct an unannounced inspection of each laboratory, which will include a review of the condition of the facility, a review of the survey logs and the radioactive material inventory. Swipes shall be made when appropriate.

Recommendations will be made, in writing, to the Laboratory Authority, who will respond to the recommendations and acknowledge he has read the report by signing it.

It will be the responsibility of the Laboratory Authority to carry out the recommendations as soon as possible, but never later than 90 days without the explicit approval of the Radiation Safety Committee.

4.7 RADIOACTIVE WASTE DISPOSAL PROCEDURE

4.7.1 Waste Categories

Radioactive wastes generally include isotopes with a short half-life (less than 15 days; e.g. P-32 and Ca-47); an ~~intermediate~~ ^{very short} half-life (15 - 65 days; e.g. P-33, Cr-51, Fe-59, Hg-203 and I-125); and a long half-life (65⁹⁰ days or longer; e.g. C-14, H-3, S-35, Ca-45, Mn-54 and Zn-65).

Types of radioactive waste include dry solids, liquids, and animal carcasses.

Dry solid waste is primarily composed of paper, plastic or glass that become contaminated during work with isotopes. No free liquid is allowed in this type of waste.

Both aqueous and nonaqueous liquid wastes are generated. These liquids are used in conjunction with the experimental protocols. Liquid scintillation fluids constitute the major portion of nonaqueous liquids being generated because of the need to analyze samples.

Animal carcasses comprise the last type of radioactive waste. They are generated because some experimental protocols require that animals be administered isotopes.

4.7.2 Collection of Waste By Laboratory Personnel

Waste must be segregated into the following groups based on half-life: Δ short, intermediate and long-lived. VERY SHORT,

All receptacles and packages containing waste must be labelled "Caution - Radioactive Material," Δ OR "CAUTION - RADIOACTIVE WASTE."

Dry Solid:

- Waste is collected only in plastic-lined 5-gallon, 20-gallon or 55-gallon containers provided by the Radiation Safety Office.
- Prior to removal from the laboratory, activity estimates must be determined for each isotope in the container. The estimates should be as exact as possible.

Liquids:

- Bulk liquids are collected in 1-gallon or 5-gallon containers. Most plastic or glass bottles are approved for

storage of liquid waste, except plastic milk jugs. Aqueous liquid must be segregated from nonaqueous liquid. Aqueous liquids containing H-3 or C-14 must be segregated from all other aqueous liquids in order to simplify sink disposal by the RSO.

- Prior to removal from the laboratory, activity determinations for each isotope in the container must be made. In order to determine activities, analyze aliquots of each container and convert to total container activity in uCi.
- Liquid scintillation vials are to be collected upright if possible. Collect in trays, plastic-lined boxes or 55-gallon drums. The vials must be segregated according to specific activity. Specific activities less than 0.05 uCi/ml must be separate from all others. Additionally, H-3 and C-14 less than 0.05 uCi/ml must be kept separate from any other isotopes because of less-expensive disposal methods.
- Prior to removal from the laboratory, activity estimates must be determined for each isotope in the container. When feasible, exact counts on vials can be totaled and converted to uCi.
- All original solutions and first rinses must be collected as waste. Other rinses or equipment decontamination water can be released into the sanitary system if:
 1. the liquid is readily soluble or dispersible in water,
 2. the total release is not greater than 1 uCi per day, and
 3. the release is flushed with copious amounts of water.

Animal Carcasses:

- Carcasses are collected in plastic bags or plastic containers. They must be

maintained frozen until they are removed. Carcasses must be segregated according to specific activity. ~~Specific activities less than 0.05 uCi/g must be separate from all others.~~ Additionally, H-3 and C-14 less than 0.05 uCi/g must be kept separate from any other isotopes to allow for incineration by the RSO.

- Prior to removal from the laboratory, activity determinations must be made. Since specific activity is known, the weight of the carcass is multiplied by the specific activity to yield the total activity in uCi.

4.7.3 Waste Removal From Laboratories

Radiation Safety personnel remove waste from laboratories every 3 months. Removals on an interim basis can be arranged as necessary.

Prior to removal from a laboratory, each box or container must be properly labelled with a 'Radioactive Waste' label. This will identify:

- the senior user,
- the isotope(s),
- the activity corrected for decay, and
- the waste type.

No more than one waste type can be marked on each label.

4.7.4 Waste Packaging By Radiation Safety Personnel

VERY SHORT
A Short- and Intermediate-Lived Waste (less than ~~65~~⁹⁰ days)

- Dry Solid:

Plastic liner is placed in a 55-gallon drum. After the drum is filled with waste, the bag is twisted shut and se-

cured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. The drum is then numbered with an indelible marker.

- Liquids:

Bulk liquids are packed using a plastic-lined 55-gallon drum. After 6 inches of vermiculite are added, approximately six jugs of waste are placed in the drum. Vermiculite is added until 2 inches above the layer of jugs. One more layer of jugs is placed in the drum with vermiculite added as before. The plastic liner is twisted shut and secured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. The drum is numbered with an indelible marker.

Liquid scintillation fluids are not held for decay due to their hazardous chemical composition. They are handled the same way as scintillation fluid containing isotopes with long half-lives.

- Animal Carcasses:

Carcasses are not packaged in drums because of biological degradation. They are maintained frozen until 10 half-lives have elapsed.

Long-Lived Waste (~~65~~⁹⁰ days or longer)

- Dry Solid:

Dry waste is packed in a plastic-lined 55-gallon drum. Compactible waste is packed separately from noncompactible waste. Once the drum is full, the plastic liner is twisted shut and secured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. The drum is numbered with an indelible marker.

- Liquids:

Bulk aqueous liquids primarily containing H-3 and C-14 are released into the sanitary system every 3 months.

The magnitude of the release is contingent upon adherence to the regulations in 10 CFR 20.

Any bulk liquids not released to the sanitary system are packed in 55-gallon drums. Several inches of vermiculite are put in the bottom of the drum. A plastic liner is put into the drum and 6 inches of vermiculite is added. Approximately six jugs of waste are placed in the drum. Vermiculite is added around and to several inches above the top of the jugs. One more layer of jugs is placed in the drum and covered with vermiculite. No more than 15 gallons of liquid are allowed per drum.

Once the drum is filled with jugs and vermiculite, the plastic liner is twisted shut and secured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. The drum is numbered with an indelible marker.

Liquid scintillation fluid in vials is packaged according to the specific activity of the fluid and the half life of the isotopes. Specific activities less than 0.05 uCi/ml of H-3 and C-14 are to be segregated from all other isotopes. Vials containing isotopes with half lives less than 70 days are to be segregated from all other types.

These three types of fluid in vials are packaged identically. Six inches of vermiculite are added to a plastic-lined 55-gallon drum. A second liner is put in the drum, followed by the addition of vials until the drum is full. Each plastic liner is twisted shut and secured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. The drum is numbered with an indelible marker.

- Animal Carcasses:

Specific activity also determines the disposal method for animal carcasses. Those with less than 0.05 uCi/g of H-3 or C-14 can be incinerated. Carcasses

containing 0.05 uCi/g or greater of H-3 or C-14 and any other isotopes must be packaged.

For carcasses that are packaged, a plastic-lined 30-gallon drum has 6 inches of vermiculite and lime (10 parts to 1 part) added. This mixture is used to retard biological degradation. Then alternate layers of carcasses and vermiculite/lime are added until the drum is full. The plastic liner is twisted shut and secured with masking tape. A gasketed lid is bolted onto the drum with a closure ring. This drum is placed inside a 55-gallon drum, with vermiculite added to fill the void spaces. A gasketed lid is bolted onto the drum with a closure ring. The drum is numbered with an indelible marker.

4.7.5 Final Disposition Of Waste

VERY SHORT-

- A Short- and Intermediate-Lived Waste:

Drums are surveyed for radiation using GM or ion-chamber portable survey instruments. Contamination surveys are performed with filter paper swipes and analyzed in a liquid scintillation counter. The drums are labelled in accordance with DOT regulations and manifested. Then they are transported to the Waste Storage Building and stored for 10 half-lives.

After this decay period, the waste is surveyed with a frisker to ensure that the waste has reached background levels. During the survey process, any "Caution - Radioactive Material" labels present are removed from the waste. The cleared waste is disposed of according to type:

- dry solids to the landfill,
- liquids to the sanitary system, and
- carcasses to the incinerator.

ATTACHMENT V

ALARA COMMITMENT



VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

OFFICE OF THE VICE PRESIDENT FOR ADMINISTRATION AND OPERATIONS (703) 961-6233

August 21, 1984

Commitment for Maintaining Occupational Radiation ExposureAs Low As Reasonably Achievable

Although occupational radiation doses at VPI & SU are very low and current occupational limits provide a very low risk of injury, the management at VPI & SU recognizes that it is prudent to avoid unnecessary exposure. It is therefore the policy of VPI & SU to reduce occupational exposures as far below the limits cited in 10CFR20 as is reasonably achievable. This will be accomplished through sound radiation protection planning and practice, as well as a commitment to policies that promote vigilance against unsafe practice.

A handwritten signature in cursive script, reading "William R. Van Dresser".

William R. Van Dresser
Vice President for Administration and Operations