

Radiation Safety Manual

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
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- [Preface](#)
 - [Emergency Service and Phone Numbers](#)
 - [Radiation Safety Committee](#)
 - [Abbreviations Used in this Manual](#)
 - [Table of Contents](#)
-

Radiation Safety Manual

Prepared for the Office of Health and Safety, Centers for Disease Control,
by the Radiation Safety Committee

Preface

These radiation safety requirements were prepared and approved by the Centers for Disease Control and Prevention (CDC) Radiation Safety Committee with the guidance of the CDC Radiation Safety Officer for CDC laboratory scientists and technical staff who use radioactive material licensed by the Nuclear Regulatory Commission. Applicable regulations are incorporated in this manual, along with procedures for handling radioactive material. The manual is a practical reference, but users must also have technical knowledge of radiation and some experience in handling radioactive materials.

The safety requirements provided in this manual form the basic program. The Office of Health and Safety provides radioisotope users with required safety procedures on the use of radioactive materials in the laboratory setting and on general laboratory practices.

The Radiation Safety Manual is one chapter of the CDC/ATSDR Occupational Health and Safety Manual.

Emergency Telephone Numbers

1. **FOR MAJOR ACCIDENTS OR ACCIDENTS INVOLVING SERIOUS INJURIES, CALL THE EMERGENCY MEDICAL SERVICE:**
 - Clifton Road: 9-911
 - Chamblee: 9-911

When calling 911, inform the Emergency Medical Service (EMS) dispatcher that **the accident involves radioactive material.**

The EMS dispatcher will ask the caller many questions. The caller should stay calm, and give as much information as possible on the nature of the accident and the injuries involved. The caller should stay on the line until instructed to hang up.

2. Call the CDC **Office of Health and Safety** (OHS)
 - During business hours:
 - (404) 639-2453
 - After business hours:

- (404) 639-2888
(CDC Security Control Room - Clifton Road)
 - 3. Call the **Occupational Health Clinic (OHC)**
 - During business hours:
 - (404) 639-3385 (Clifton Road)
 - (770) 488-7824 (Chamblee)
 - After business hours:
 - (404) 639-2888
(CDC Security Control Room - Clifton Room)
 - 4. **FOR OTHER THAN MAJOR ACCIDENTS, CALL**
 - During business hours:
 - (404) 639-2453 (OHS)
 - (404) 639-3385 (OHC)
 - After business hours:
 - (404) 639-2888
(CDC Security Control Room - Clifton Road)
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CDC Radiation Safety Committee

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Abbreviations Used in This Manual

- **ALARA** - As Low as Reasonably Achievable
 - **ALI** - Annual Limit on Intake
 - **AU** - Authorized User
 - **CDC** - Centers for Disease Control and Prevention
 - **Ci** - Curie
 - **cm²** - square centimeters
 - **cpm** - counts per minute
 - **DAC** - Derived Air Concentration
 - **dpm** - disintegrations per minute
 - **GM** - Geiger-Muller
 - **Nal** - Sodium Iodide
 - **kg** - kilogram
 - **lfm** - linear feet per minute
 - **LSC** - Liquid Scintillation Counter
 - **mCi** - milliCurie
 - **ml** - milliliters
 - **MeV** - mega electron-volts
 - **mrem** - millirem (0.001 rem)
 - **NRC** - Nuclear Regulatory Commission
 - **OHC** - Occupational Health Clinic
 - **OHS** - Office of Health and Safety
 - **PSA** - Physical Security Activity
 - **RIA** - Radioimmunoassay
 - **RSC** - Radiation Safety Committee
 - **RSO** - Radiation Safety Officer
 - **TLD** - Thermoluminescent Dosimeter
 - **³H** - Tritium (hydrogen-3)
 - **¹⁴C** - Carbon-14
 - **³²P** - Phosphorous-32
 - **³³P** - Phosphorous-33
 - **³⁵S** - Sulfur -35
 - **⁵¹Cr** - Chromium-51
 - **⁶⁰Co** - Cobalt-60
 - **¹²⁵I** - Iodine-125
 - **¹²⁹I** - Iodine-129
 - **¹³¹I** - Iodine-131
 - **¹³⁷Cs** - Cesium-137
 - **10 CFR 19** - NRC's Title 10, Chapter 1, Code of Federal Regulations, Part 19
 - **10 CFR 20** - NRC's Title 10, Chapter 1, Code of Federal Regulations, Part 20
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TABLE OF CONTENTS

Emergency Telephone Numbers
Preface
CDC Radiation Safety Committee
Abbreviations Used in This Manual

Part 1: Radiation Safety Program

- I. **Federal Regulations**
 - A. [Licenses](#)
 - B. [Regulations](#)
- II. **Program Operations**
 - A. [Administration of the Radiation Safety Program](#)
 - B. [Physical Security of Radioactive Materials](#)
 - C. ["As Low as Reasonably Achievable" \(ALARA\) Philosophy](#)
 - D. [Authorized Users](#)
 - E. [Radiation Workers](#)
 - F. [Permitted Workers](#)
 - G. [Training](#)

- H. [Procurement](#)
- I. [Inventory and Records](#)
- J. [Personnel Monitoring](#)
- K. [Radiation Exposure During Pregnancy](#)
- L. [Laboratory Supplies and Equipment](#)
- M. [Bioassay](#)
- N. [Labeling](#)
- O. [Surveys](#)
- P. [Radioactive Waste Disposal](#)

Part 2: Emergency Procedures

- I. [Role of the Office of Health and Safety](#)
- II. [General Emergency Procedures](#)
- III. [Specific Emergency Procedures](#)
 - A. [Spills](#)
 - B. [Fire](#)
 - C. [Explosion](#)
 - D. [Accidents Involving Large Sources](#)

Bibliography

Appendices:

- A. [Radiation Safety Committee Charter](#)
- B. [Radiation Dose Standards](#)
- C. [Radiation Safety Due Dates](#)

Glossary

Part 1: Radiation Safety Program

I. Federal Regulations

A. LICENSES

The Centers for Disease Control and Prevention (CDC) operates under two specific licenses issued by the United States Nuclear Regulatory Commission (NRC) and must comply with the terms of each license using any radioisotopes that are produced as by-product materials in a nuclear reactor. The uses of naturally occurring radioisotopes, like radium, or cyclotron produced radioisotopes, are not under the jurisdiction of the NRC. However, the CDC's radiation safety procedures should be followed for any radioisotopes or radiation producing equipment, like x-ray machines.

B. REGULATIONS

Standards for protection from radiation are published in NRC's **Rules and Regulations**, Title 10, Chapter 1, Code of Federal Regulations, Part 19, titled "Notices, Instructions, and Reports to Workers; Inspections," and Part 20, titled "Standards for Protection Against Radiation." They are referred to in this manual as "10 CFR 19" and "10 CFR 20," respectively. **These regulations may also be viewed via the Internet at <http://www.nrc.gov/NRC/CFR/index.html>.** Additional requirements are included in the NRC licenses issued to CDC governing the possession and use of radioisotopes. Employees are encouraged to refer to these standards and the current licenses.

II. Program Operations

A. ADMINISTRATION OF THE RADIATION SAFETY PROGRAM

The Office of Health and Safety (OHS) has overall responsibility for developing and administering the occupational safety and health program at CDC, including the Radiation Safety Program. The Director, OHS, reports to the Deputy Director, CDC. The Radiation Safety Program is managed by the Radiation Safety Officer (RSO) who is a member of the OHS staff and serves on the Radiation Safety Committee. The

Radiation Safety Committee (RSC) provides for oversight of the CDC Radiation Safety Program to ensure safe use of radioactive material in areas under the control of CDC in all Atlanta facilities. The RSC is responsible for formulating policy with regard to radiation safety at CDC and protection of the environment to ensure compliance with Federal regulations, including those of the U.S. Nuclear Regulatory Commission (NRC). In an emergency, the Director, OHS, or his designee may act for the RSO and RSC when necessary to control or prevent an incident involving radioactive materials, including the temporary ordering cessation of laboratory operations or withholding authority to purchase or use isotopes until the RSC reviews these infractions. The RSO and the RSC shall be provided with sufficient authority, organizational freedom, and management prerogative to accomplish these goals. These responsibilities and authorities are limited to the CDC's Radiation Safety Program served under NRC licenses 10-06772-01 and 10-06772-02.

Radiation Safety Officer (RSO) - The RSO is a professional health physicist with a degree in health physics. The RSO provides management of the day-to-day operations of the Radiation Safety Program, and assures compliance with the policies of the CDC, RSC, and the Director, OHS, and with the regulations and rules of the NRC. The duties of the RSO include:

1. Consulting with members of the RSC and users of the radioactive materials on all matters relating to the use of radioactive materials.
2. Assuring compliance with the regulations and rules of the NRC and the requirements of the CDC license to procure, use, store, secure, and dispose of radioactive materials through monitoring and periodic formal and unannounced inspections.
3. Developing and implementing procedures for periodic radiological surveys of laboratories; monitoring of personnel; handling and disposal of radioactive wastes; ordering, receiving, and distribution of radioactive materials; and use of sealed radioactive sources.
4. Developing and implementing training for all personnel involved in any facet of operations involving radioactive materials. Assuring that all CDC personnel receive periodic review of important procedures, rules, and methods.
5. Reviewing applications of new Authorized Users and protocols from existing Authorized Users before submission to the RSC.
6. Maintaining records of procurement, area monitoring, personnel monitoring, accidents and incidents, inventories, and any other documents required by the Radiation Safety Program and NRC regulations.
7. Approving requests to purchase of radioactive materials after assuring that only Authorized Users or their approved alternates place orders and that the orders for radioactive materials do not exceed established limits under CDC's license.
8. Responding to all emergencies involving radioactive materials and providing expert advice and assistance as required by the program.
9. Providing liaison between OHS and the Occupational Health Clinic on all matters relating to employee exposure to radiation, and monitoring results, etc.
10. Interacting with the NRC on issues related to the CDC's licenses, license amendments, application renewals, and inspections.
11. Assuring compliance with all "As Low As Reasonably Achievable" (ALARA) regulations as defined by 10 CFR 20.

NOTE: The Deputy Radiation Safety Officer will back-up the Radiation Safety Officer on all the aforementioned duties.

Radiation Safety Committee (RSC) - The RSC, as required by NRC regulations and conditions of CDC's License, maintains oversight of all operations involving radioactive materials and radiation-producing equipment. The RSC advises the RSO and OHS on matters relating to radiological safety and compliance with NRC regulations. The RSC shall be appointed by the Director, CDC. The duties of the RSC and the membership and organization of the RSC are provided below.

Duties of the RSC

1. Ensures the safe use and security of all radioactive materials and sources of radiation throughout CDC in Atlanta for the Director, CDC.
2. Develops and recommends policies to the Director, CDC, for the control and safe use of radiation sources and to comply with NRC regulations.
3. Reports concerns about the policies and management of the Radiation Safety Program to the Director, CDC. Reports concerns about procedures and daily operations of the Radiation Safety Program to the Director, OHS.
4. Provides technical oversight, advice, and assistance to the OHS on matters concerning radiation safety and security.
5. Receives, reviews, and acts on all applications for the use of radioactive material or radiation sources in any area used by CDC personnel. Determines that all activities involving radioactive materials and sources of radiation are being conducted safely and in accordance with applicable Federal regulations and CDC radiation safety and security policies.

6. Receives and reviews periodic reports from the OHS on contamination monitoring, personnel monitoring, inspections, and other related radiation safety matters.
7. Reviews and assesses, as necessary, the overall use of radionuclides and radiation sources used at the CDC for possible modification of possession limits.
8. Investigates all instances of alleged infractions of safety rules and security regulations and for violations of NRC requirements. Determines the course of corrective action(s) to be taken.

Membership and Organization of the RSC

The Radiation Safety Committee shall be appointed by the Director, CDC. Seven members shall be Authorized Users or Radiation Workers and shall represent the various types of users of radioactive materials or radiation sources at various Centers within CDC. In addition to the above seven appointed members, the RSC shall include: (1) the Radiation Safety Officer; (2) the Director, OHS, or his designee (representing CDC management); and (3) an occupational health physician from the Occupational Health Clinic. RSC members shall serve 3-year staggered terms to maintain continuity. The Director, CDC, may choose at her/his discretion to remove and reappoint at any time any member of the RSC. The Chairperson and the Secretary of the RSC are elected by members of the RSC and serve for 3 years. At least two members must be nominated for each office. In the election of the Chairperson, the nominee who receives the second most votes will serve as the Vice Chairperson. The Chairperson, Vice Chairperson, and Secretary may continue for additional terms if re-elected with at least two members running for each office. When members are replaced, new appointees shall be chosen to maintain the balance of membership. The RSC may recommend additional members for appointment by the Director, CDC, to improve the effectiveness of the RSC. Ex-officio members may also be appointed by the Director, CDC, the Director, OHS, or the RSC Chairperson, as needed.

The Chairperson in consultation with the RSO calls and presides over all meetings, establishes agendas, maintains close communication with the RSO and OHS, and informs the Director, CDC, of important matters related to the Radiation Safety Program. The Chairperson also establishes working groups and appoints ex-officio members to the Committee, as the Committee deems necessary. The Vice Chairperson acts as Chairperson in the absence of the same. The Secretary records minutes of all meetings and maintains official RSC files. The OHS shall provide administrative support to the Committee. Meetings shall be conducted three times a year at four month intervals. A quorum will be satisfied with half the members plus one, including the chairman or vice chairman, and the RSO or Deputy RSO (his designee).

B. PHYSICAL SECURITY OF RADIOACTIVE MATERIALS

THE RULE: ALL RADIOACTIVE MATERIALS AT CDC MUST BE SECURED OR UNDER CONSTANT SURVEILLANCE AT ALL TIMES.

All shipments of radioactive materials received at CDC must be secured or be under constant surveillance at all times. Shipments of radioactive materials which have not been delivered must be secured at the receiving site by personnel trained by OHS until delivery can be made. Delivery personnel are prohibited from delivering a package with radioactive materials unless there is an Authorized person (Authorized User, Alternate Authorized User, or Radiation Worker) at the location who will accept it, sign for its receipt, and secure the radioactive materials. Shipments of radioactive materials must not be left unsecured in corridors. If it is necessary to deliver the package to an office, the authorized person receiving the shipment must immediately secure the package in a laboratory or storage room designated for work with radioactive materials. If the delivery person cannot find an authorized person to receive the shipment, the package must be returned to the receiving areas where it will be secured in a locked cabinet until delivery can be completed. Radioactive materials are not to be left unsecured at any time.

Any radioactive material in use in a laboratory must be attended at ALL TIMES, or secured by locking the laboratory when not attended. **Radioactive materials may not be left unsecured even momentarily.** Radioactive materials in storage, i.e. not being used, must be secured when the room in which it is stored is unoccupied. The required security may be accomplished by locking the room while unoccupied, or alternatively, by locking the radioactive materials within refrigerators, freezers, cabinets, or lock boxes. Wherever possible, lock boxes are recommended for storage of radioactive materials. Only authorized persons may have access to radioactive materials. Radioactive materials that are stored or used in areas common to both authorized and unauthorized personnel must be secured at all times from unauthorized personnel. **It is strongly recommended that all laboratories containing radioactive materials be locked when unoccupied during daytime hours and at night.**

Corridors (hallways, elevator lobbies, and utility chases, etc.) are not secured areas. Therefore, the use and storage of radioactive materials in these areas are prohibited.

All radioactive wastes are considered as radioactive materials. Radioactive wastes, including dry waste,

liquid waste, medical pathological waste, and mixed waste, must be secured at all times. Radioactive waste may be placed in lockable containers which may be obtained from the Radiation Safety Office.

Unescorted unauthorized personnel may not enter into a laboratory if an authorized person is not present. Any persons admitted into the laboratory must be accompanied at all times by an authorized person who works in the area. Persons performing work in the area, such as engineering or maintenance personnel, contractors (i.e. janitorial staff, telephone, or computer support personnel) or commercial service representatives must also be accompanied by an authorized person at all times. Persons unknown to the occupants of an area where radioactive materials are used or stored should not be permitted into the area without proper identification and a legitimate reason for entry.

SANCTIONS FOR VIOLATIONS OF CDC'S RADIATION SAFETY POLICY

Failure to adhere to the rules for proper usage of radioactive materials can result in sanctions against the Authorized User or Radiation Worker. A description of these sanctions follows:

- **Level I Sanction:** This sanction will be for violations that appear to be inadvertent or occasional lapses that are discovered by CDC inspection teams. The Authorized User or Radiation Worker must provide a written explanation for the failure and provide their correction actions to prevent future failures. This explanation will be sent through the management chain to the RSC and the RSO.
- **Level II Sanction:** This sanction will be invoked for a serious violation or repeated violations that appear to indicate a lack of regard for following CDC's radiation requirements and/or exposes others to radioactive materials. This sanction involves a suspension of the Authorized User's or Radiation Worker's access to radioactive material for a minimum of 60 days. All radioactive materials will be confiscated and the Authorized User/Radiation Worker will be required to retake the radiation safety training course, as well as reapply for permission to use radioactive materials. The RSC may also recommend that additional disciplinary action be taken against the Authorized User and/or Radiation Worker.
- **Level III Sanction:** This sanction will be imposed for flagrant violations or those that intentionally set coworkers at risk of injury from radioactive materials. This sanction results in permanent revocation of the use of radioactive materials. The RSC may also recommend that additional disciplinary action be taken against the Authorized User and/or Radiation Worker.

C. "AS LOW AS REASONABLY ACHIEVABLE" (ALARA) PHILOSOPHY

The radiation safety program at CDC fully supports the concept that all radiation doses should be ALARA. This implies that no dose should be acceptable if it can be avoided or is without benefit. Our ALARA program depends on the cooperation of all users of radionuclides and their supervisors at CDC. The program includes the use of proper equipment and procedures to lower radiation exposure. The OHS will investigate any whole-body dose in excess of 125 millirems (mrem) or 1,875 mrem to the extremities to any individual in any one quarter. If any worker receives a whole-body dose in excess of 375 mrem or 5,625 mrem to the extremities per quarter, direct actions must be taken to minimize any future exposures. These actions may require a change in laboratory procedure or an increased application of the principles of personnel protection.

Maintain ALARA exposures by practicing the basic principles of radiation protection.

a. External Radiation Protection

1. **Maximize the distance from the source.** The dose rate for most gamma and x-radiation varies with the inverse square of the distance from a "point" source. Therefore, the farther you position yourself for the source of radiation, the smaller the dose you receive.

For example, doubling the distance from a radiation source will result in 1/4 the exposure in the same amount of time. One practical implementation of this principle is using remote handling devices such as forceps, tongs, and tube racks, etc. to minimize direct contact with sources and containers. Even a small increase in distance can result in a dramatic decrease in dose rate.

2. **Minimize time of exposure.** The less time you remain in a radiation field, the smaller the dose you receive. Perform the experiment or the procedure as quickly and as efficiently as possible without increasing the probability of a spill or other accident.
3. **Shield the radiation source.** Place shielding between yourself and a source of penetrating radiation to decrease your dose. For low energy beta emitters: (^3H , ^{14}C , ^{33}P , and ^{35}S) shielding is not necessary. For high energy beta emitters (^{32}P), 3/8" acrylic is the shielding material of choice. For gamma or x-ray emitters (^{51}Cr and ^{125}I) lead is used when exposure rates are significant.

b. **Internal Exposure Protection**

1. **Inhalation:** A chemical fume hood which has been certified for radioactive materials work is highly recommended when using potentially volatile compounds. Certain equipment is capable of generating radioactive aerosols. Use centrifuges, vortex mixers, shakers, and chromatography plate scraping procedures, etc. in such a way that production of and exposure to radioactive aerosols is minimized.
2. **Puncture:** Dispose of syringes and pipettes promptly and in appropriate containers. Guard against glass breakage and puncture injury during use and disposal. Do not attempt to recap needles before disposal.
3. **Ingestion:** NEVER introduce any food or drink into a posted restricted area, even for temporary storage. DO NOT eat or drink in any area where radionuclides are used, never pipette by mouth, and never store food and drinks in a cold room or refrigerator that is designated for radioactive material storage.
4. **Absorption:** Use measures that prevent the contamination of skin and eyes. If there is any possibility that the clothes have been contaminated, remove this clothing before leaving the lab. Eye protection, (e.g. goggles, face shield) is encouraged to prevent contamination of the eyes. This is particularly important for individuals wearing contact lenses since some lenses will absorb and concentrate radiochemicals. Wear protective gloves at all times when working with radioactive materials. Change gloves frequently during the work, disposing of the used gloves as radioactive waste. Wash hands after using radioactive materials and monitor the hands for contamination, especially before eating or smoking, and prior to leaving the laboratory.

D. AUTHORIZED USERS

All work involving radioactive material must be conducted under the auspices of an approved Authorized User. Each Authorized User is ultimately responsible for the safety of those who use radioisotopes under his/her supervision. To become an Authorized User, one must submit CDC form 0.1005, Authorized User Form to the RSO and the RSC for approval.

The RSC, upon recommendations from the RSO, must approve the appointment of all Authorized Users. Approval carries many responsibilities. Each Authorized User must be familiar with 10 CFR 19, 10 CFR 20, safe radiological procedures, and all related requirements of the OHS. **Each Authorized User should designate an Alternate Authorized User and list their experience and training on the Authorized User Form, which should be submitted to the RSO and the RSC. The Alternate serves in the absence of the Authorized User and can assume any duties as assigned.** Any delegation of work does not shift responsibility from the Authorized User. He or she must provide adequate supervision to ensure the safety of all personnel using radioisotopes and of any persons who work in the vicinity of the radioactive materials. Authorized Users are expected to fully support the ALARA program.

The Authorized User must:

1. Call the emergency medical service or fire department (both at 9-911) immediately for any fire, explosion, or major accident and tell the dispatcher that the accident involves radioactive materials. Then: notify OHS immediately.
2. Notify RSO/OHS immediately of any spill of radioactive materials and any known or suspected overexposure of personnel. Follow the procedures for a spill as outlined in Part 2, Section III of this manual.
3. Ensure that all laboratory personnel, including guest investigators, complete the CDC Radiation Safety in the Laboratory course or have had sufficient training as certified by the RSO to begin work in the laboratory as Radiation Workers.
4. Ensure that the security plan for radioactive materials is submitted with the Authorized User Form. This form should follow the security recommendations outlined in this Manual. Immediately notify the RSO/OHS of any necessary changes in the laboratory's security plan. Strict adherence to the Security Plan is required.
5. Properly label all radioactive materials and display proper signage designating radionuclide usage in the laboratory.
6. List all Radiation Workers and Permitted Workers who use radioactive materials on their Authorized User Form. All personnel that join the laboratory and work with radioactivity should complete CDC form 0.871, Request for Radiation Monitoring Badge and be added to the Authorized User Form after completing their training.
7. Ensure that all laboratory personnel comply with CDC radiation safety regulations, policies, and procedures governing the use of radioactive materials as outlined in this Manual and required by the Nuclear Regulatory Commission.
8. Notify the RSO immediately of any termination of employment of Radiation Workers who that are listed on the Authorized User Form by submitting either a corrected page of the form or other written notification. The personal monitoring equipment should be returned to the RSO at the same time.
9. Instruct laboratory personnel in the proper use of personnel monitoring equipment such as

- thermoluminescent dosimeters (TLD's) when appropriate, and confirm that this equipment is always worn in the laboratory where any procedures involving radioactive materials are performed.
10. Ensure that all orders for radioactive materials are initiated only by the Authorized User or his/her representative.
 11. Ensure that all orders are received only by the Authorized User or his/her Alternate or designated Radiation Worker and that the radioactive materials are immediately stored in a secured laboratory or storage area designated for radioactive material.
 12. Keep complete and accurate records of all radioisotopes received, used, and disposed of and supply the OHS with this information every four months or when requested. Each Authorized User should have an up-to-date record of the quantity of radioisotopes on hand at any given time.
 13. Assume responsibility for the proper disposal of all radioactive waste. Maintain exposures ALARA through laboratory procedures, shielding, and the use of gloves and other protective clothing.
 14. Assist the RSO, RSC, or OHS in any surveys that are conducted as part of the CDC Radiation Safety Program.
 15. Ensure that laboratory is surveyed frequently enough to ensure that it is free of contamination, i.e. at least once per month. Specific instructions for surveys are in Part 1, Section O of this Radiation Safety Manual. Ensure that all problems in the laboratory related to radiation safety are identified and corrected in a timely manner or as soon as identified as the result of an authorized survey.
 16. Ensure that all equipment leaving the laboratory is surveyed and decontaminated before being excessed or sent for repair.
 17. Notify the RSO if work with radioisotopes is terminated. The Authorized User can permanently discontinue work with radioactive materials, or can be put on Inactive status, which would imply that work may continue in the future. Inactive Users can be returned to Active status within 2 years if a revised Authorized User Form is completed and submitted to the RSC for approval.
 18. Return to the OHS all radioactive material, personnel monitoring badges, radiation meters, and any other issued materials or equipment when work with radioisotopes is terminated or the Authorized User goes on Inactive status. Also, remove all radiation-related signs from the laboratory.
 19. Every 2 years, all Authorized Users must renew their authorization to continue using radioisotopes. This renewal shall include a review of all application protocols, procedures, and personnel assignments. If a User does not plan to use radioisotopes within the 2 year renewal period, the authorization will be terminated and renewed when authorization is again required.
 20. Be responsible for the clearance of laboratories, storage areas, and other facilities under their authorization prior to vacating or renovating such facilities.
 21. If applicable, attend the OHS Gammacell Irradiation course to become an Authorized User of the ^{137}Cs and ^{60}Co gammacell irradiators. Ensure that all personnel in your laboratory using the irradiators also attend the course or only use the irradiators in the presence and under the supervision of those individuals listed in the license as authorized to use this source.

E. RADIATION WORKERS

Radiation Workers are those personnel listed on the Authorized User Form of the supervisor to conduct work with radioactive materials.

The Radiation Worker must:

1. Attend the OHS Radiation Safety in the Laboratory course prior to beginning work with radioactive materials. Any exceptions to this must be made by the RSO.
2. Read the CDC Radiation Safety Manual and be responsible for its contents as applicable to their duties in the laboratory.
3. Call the emergency medical service or fire department (both at 9-911) immediately for any fire, explosion, or major accident and tell the dispatcher that the accident involves radioactive materials. Next, notify OHS and their immediate supervisor and/or the Authorized User responsible for their laboratory.
4. Notify RSO/OHS immediately of any spill of radioactive materials and any known or suspected radiation exposure. Follow the procedures for a spill as outlined in Part 2, Section III.
5. Adhere to all CDC radiation safety regulations, policies, and procedures governing the use of radioactive materials as outlined in this Manual and required by the Nuclear Regulatory Commission.
6. Follow the recommendations of the Authorized User for those procedures that are specific to their laboratory for the storage, usage, recording, and disposal of radioactive materials.
7. Receive necessary on-the-job training from the Authorized User as it relates to the duties of the job.
8. Maintain exposures ALARA through laboratory procedures, shielding, and the use of gloves and other protective clothing.

F. PERMITTED WORKERS

A permitted worker is a laboratory worker who does not work with radioactive materials but works in a radiation laboratory. To be a permitted worker, the employee must successfully complete the first

day of the "Radiation Safety in the Laboratory Course" or equivalent.

The duties of Permitted Workers are as follows:

1. Enroll, attend and complete the first day of the Radiation Safety in the Laboratory Course.
2. Wear issued radiation monitoring badges at all times in the radiation laboratory.
3. Use the principles of time, distance, and shielding to protect themselves from radiation exposure.
4. Confer with radiation workers to find out where radioisotopes are used and stored so that these areas can be avoided.
5. Report any observed radiation safety infractions, shortcomings, or failures to the RSO in a timely manner.

G. TRAINING

All Authorized Users and Radiation Workers under their supervision who work with radioisotopes must receive instruction on radiation safety, biological effects of radiation, regulatory requirements, and laboratory techniques. The CDC Radiation Safety Program is designed to achieve strict compliance with applicable Federal regulations. *Title 10, Code of Federal Regulations, Part 19, Section 12 "Instructions to Workers" (10 CFR 19.12)* is the regulation requiring training of all individuals working in or frequenting any portion of a restricted area associated with radioactive materials or radiation. To meet the regulatory requirements on the training of radiation workers, the OHS operates an extensive training program. The type of radiation safety training required depends on the nature of their involvement with sources of radiation.

Records of all training, including documentation of attendance are required to be maintained by OHS for review by NRC inspectors.

Visiting scientists or contract personnel are NOT to undertake work involving radioactive material until they have taken the appropriate safety training courses and are under the supervision of an Authorized User.

Regularly Scheduled Courses:

Biannually, CDC provides an entry-level course entitled "Radiation Safety in the Laboratory" for laboratory personnel who use radioisotopes. BEFORE working with radioisotopes, laboratorians must complete the radiation safety course. This course includes a discussion of all radiological hazards that workers may encounter, including spills or other incidents. Required procedures such as lab surveys are demonstrated, and all necessary documentation to be maintained by the Authorized User or radiation worker (laboratorian) are explained.

Annually the RSO provides a refresher training course for all laboratorians working with radioactive materials, to update them on training and to present information about new regulations or procedures. Because violations may have occurred during the past year as noted by the RSO during laboratory surveys, the RSO will also re-emphasize certain rules and regulations.

In accordance with the CDC license requirements, each worker using the ^{60}Co and ^{137}Cs Gammacell sources must meet the requirements outlined above and must be specifically trained in the use of these irradiators by taking the course "Use of the Gammacell Irradiators," which is offered biannually.

To be an Authorized User, laboratorians must document that they have completed the basic radiation safety training courses, in addition to all other courses taken at CDC or at other institutions where they may have worked prior to coming to CDC.

Specialized Courses:

All ancillary non-laboratorian persons who frequent restricted areas, such as janitorial workers, secretarial staff, security guards, engineering service personnel, and shipping and receiving workers, must receive instruction provided by the RSO in accordance with 10 CFR 19 & 20. These courses are conducted as needed by the RSO, tailored to the needs of these occupational groups, and are designed to inform these non-laboratory personnel about radiation hazards and appropriate precautions.

Returning Workers:

If a laboratorian has been in an inactive status for more than two years, he/she will be required to retake the "Radiation Safety in the Laboratory Course." The former Authorized User must reapply for authorization and

must update all required training and experience information on the Authorized User application, and then must be re-authorized by approval of the Radiation Safety Committee.

Laboratorians may contact the RSO or OHS for additional course information or check the OHS home page on the CDC Intranet (<http://inside.cdc.gov/intranet/ohs>) (where the entire Radiation Safety Manual is also available). The RSO regularly notifies all Authorized Users of upcoming courses. Some information may also be found on the OHS Internet (<http://www.cdc.gov/od/ohs>).

H. PROCUREMENT

1. Ordering Radioisotopes and Other Radioactive Materials:

Prior to being ordered or received, approval by OHS must be obtained for all radioactive materials, radiation sources, radiation-producing equipment, self-shielded irradiators, gas chromatographs with radioactive sources, medical diagnostic and therapy devices using radioactive sources or any other equipment or materials containing or capable of producing ionizing radiation.

All orders for radioactive materials must be approved by Authorized Users or their alternates before being forwarded to OHS through the CDC procurement system. The CDC form 50.113A entitled "Delivery Order Request form" may be used as a working document for submitting radioactive material orders to their administrative office and to OHS, as necessary.

NOTE: The OHS maintains administrative control over certain items that are not by-product materials, such as x-ray equipment, gas chromatographs sources, gammacell irradiators. The same procurement procedures described above are to be followed for these items.

2. Receiving and Opening Radioactive Packages:

All packages containing radioactive materials must be surveyed to determine if the exterior is contaminated and/or if the contents have leaked. If the package is not contaminated, the RSO or his designee will stamp the package approved and will sign and date it. After being recorded in the radioactive material logbook, packages will be delivered to the Authorized User/laboratorian.

If an Authorized User or Radiation Worker opens a package and discovers that the contents have been spilled because the container has been broken or cracked, he or she must notify the OHS immediately for guidance. The package should be contained to a restricted area to minimize spread of contamination until it can be safely sealed and removed.

I. INVENTORY AND RECORDS

An Authorized User and/or a designee must keep records of all radioactive materials ordered, received, and disposed. The Radioisotope Inventory may be maintained on CDC form 0.1003 Radioisotope Inventory Report. Authorized Users or Radiation Workers will forward a copy of the radioisotope inventory report form to the RSO on March 1, July 1, and November 1 of each year. Attached to the inventory report form will be a copy of all of the User's packing slips associated with all incoming radioactive material packages. The name of the preparer and his/her telephone number must be clearly indicated on the form. **Records must be maintained by the AU for a period of 3 years.**

Note: Packing slips must be strictly maintained to keep an accurate inventory. To accurately document the amount of radioactive material used at the workbench, a Radioactive Material Inventory Tally Sheet CDC form 0.1159 may be maintained. Inventory reports submitted on CDC form 0.1003 should include the name of the physical/chemical form of the radioactive material, the amount (in millicuries) of radioactive waste, and the net quantity (in millicuries) of the radioisotopes on hand in the laboratory. The date of assay is required for accurately determining the exact activity on hand at any date. If the date of assay is not provided by the manufacturer, then use the date received in the laboratory as the date of assay and calculate the activity of the radioisotope using this assumption.

J. PERSONNEL MONITORING

Dosimeters – Personal monitoring devices (dosimeters) are required for workers who may receive 10 percent of the maximum dose of external radiation permissible under NRC's regulations (Table 1). To apply for a monitoring device, laboratorians must complete CDC form 0.871, Request for Radiation Monitoring Badge, and return it to the Radiation Safety Office. The RSO will request the dosimetry records of new radiation workers from other institutions where they used radioactive materials. Old and new dosimetry

records will be added to obtain cumulative records.

Table 1

| Annual Maximum Permissible Dose Equivalent in mrem | |
|--|--------|
| Whole body | 5,000 |
| Lens of the eye | 15,000 |
| Skin | 50,000 |
| Extremities (Hand, forearms, feet, ankles) | 50,000 |
| TLD's will be used for monitoring gamma and high-energy, beta-emitting radioisotopes, such as ³² P, ⁵¹ Cr, and ¹²⁵ I. The OHS may use radiation dosimeters to monitor levels of radiation in laboratories or other areas. | |

An accurate record of an employee's radiation exposure history must be maintained by OHS. Employees must provide information regarding any prior occupational radiation exposure on CDC form 0.871, Request for Radiation Monitoring Badge. If a worker is occupationally exposed to radiation elsewhere in addition to being exposed at CDC, the Authorized User should report this to the OHS so that an accurate record of the worker's total radiation exposure can be maintained.

Employees must wear dosimeters recommended by the Radiation Safety Office while working in any restricted area (see Glossary). While not being worn, dosimeters should be stored away from all radiation sources in a desk drawer or in some other location where they will not be exposed to excessive heat, sunlight, or moisture (for example, never left in a car). They are not to be worn off CDC premises. Individuals who do not work directly with radioisotopes or in a laboratory where radioisotopes are used may be issued dosimeters. **NOTE: Individuals who wear radiation badges should review their radiation dosimetry records to ascertain their radiation exposures in the radiation laboratory.**

Any dosimeter contaminated or exposed to heat, moisture, or medical x-rays should be returned to the Radiation Safety Office for replacement. After any accident or if an overexposure is suspected, the dosimeters should be returned immediately to the Radiation Safety Office to be read. Dosimeters should be worn on a shirt, coat pocket, lapel, or in some other position between the waist and the shoulders that will be representative of any radiation exposure. If, during a radiological process, a hand might receive a dose, a ring dosimeter should be worn on a finger of the hand under the glove. When both whole-body and hand doses can occur, two dosimeters will be issued, one for the whole body and one for a hand.

Authorized Users are responsible for distributing and collecting dosimeters for laboratory personnel under their authorization. Ring and whole-body dosimeters will be exchanged quarterly through the Radiation Safety Office. The Radiation Safety Office will keep a record of any dose received and will send each worker a copy of his or her exposure record upon request.

Maximum Permissible Doses – Federal limits for radiation doses are provided in Table 1; however, all doses must be maintained ALARA.

The maximum permissible dose for persons under 18 years of age is 10 percent of the doses shown in Table 1. At CDC, employees under 18 years of age are not allowed to use radioactive materials. Exposure to pregnant women must be controlled so that the fetus will not receive more than 500 mrem during the entire gestation period (see Part 1, Section K). The Radiation Safety Office must be informed of any pregnant employees who may be exposed to radiation. The OHS through the RSC and the RSO shall take any action deemed necessary to protect these employees without affecting their employment status.

Internal exposures must be prevented. Work procedures and equipment must be designed to prevent the release of any radioactive substance into room air. Processes that involve volatile or gaseous material or that generate particulates must be confined to an approved fume hood operating with a face velocity of at least 100 fpm or to an approved glove box. Air flow rates on all hoods should be monitored and calibrated at least annually. Uncalibrated hoods should be timely reported to the OHS.

K. RADIATION EXPOSURE DURING PREGNANCY

Employees who become pregnant are strongly encouraged to notify her supervisor and the RSO in writing as soon as possible. A description of predicted usage of radionuclides and procedures to be performed during the gestation period should be sent to the RSC and the RSO for evaluation. The RSC and the RSO will inform the pregnant woman and her supervisor of individual actions that may need to be taken to ensure compliance with the 500 mrem rule, i.e. the fetus will not receive more than 500 mrem during the entire gestation period. Medical documentation of pregnancy is not required unless modification of assignment is necessary. If desired, confirmation of pregnancy may be obtained free of charge through the CDC Occupational Health Clinic.

ALARA recommendations on pregnancy and radiation exposure include:

1. Notifying of supervisor immediately when pregnancy is known or suspected.
2. Wearing a lead apron while performing work with certain radionuclides.
3. Using extra shielding such as lead-lined waste containers for gamma emitters.
4. Wearing radiation badges (worn at the waist) to be read monthly, not quarterly;
5. Deferring the receipt of unshielded stocks of radionuclides.
6. Leaving work area where more than one millicurie of certain radionuclides are being used.

The 500 mrem value for the fetus does not create a basis for discrimination and should be achieved in conformance with the provision of Title VII of the Civil Rights Act of 1964, as amended, regarding discrimination in employment practices, including hiring; discharge; compensation; and terms, conditions, or privileges of employment.

L. LABORATORY SUPPLIES AND EQUIPMENT

The following supplies and equipment are recommended for laboratories where radioisotopes are used:

1. Fume hood with minimum flow rate of 100 linear feet per minute (lfm) (if volatile radioactive solutions are used).
2. Shielding, transparent, acrylic beta shields, acrylic boxes or lead bricks, when necessary.
3. Laboratory coats, disposable gloves, and protective eyeglasses.
4. Remote pipetting devices and aerosol resistant tips. Preferably, at least one set of pipetteors dedicated for radioisotope usage only.
5. Absorbent paper with impervious plastic backing for work areas.
6. Appropriate personnel monitoring badges and finger rings.
7. Appropriate signs and labels for doors, centrifuges, incubators, freezers, refrigerators, hoods, glassware, and other containers holding radioactive substances.
8. Lockable waste containers.
9. Plastic bags (i.e., not "Biohazard") are for radioactive waste disposal.
10. Lockable isotope storage boxes which can be properly secured to refrigerator or freezer.
11. Laboratory record book for maintaining inventories and surveys.
12. Copy of the CDC Radiation Safety Manual.
13. Appropriate, calibrated survey meters and materials for conducting wipe tests.
14. Supplies for keeping the area clean and free of contamination.
15. Posted current NRC Form 3.
16. Clearly labeled spill kit in each room where radioisotopes are used.

M. BIOASSAY

Some laboratory exposures to radiation may occur by the inhalation, ingestion, or skin absorption of radioactive material and may result in internal radiation exposures, which are measured by bioassay methods. These methods look for radioactivity in either the entire body (whole-body count monitoring) or in particular organs or body fluids (such as thyroid count monitoring and urine specimen radioassays).

Since the principles of external protection, i.e. time, distance, and shielding are not applicable, safety measures should be implemented to prevent internal radiation exposures. Work procedures and equipment must be designed to prevent the release of any radioactive substance into room air. Processes that involve volatile or gaseous material or that generate particulates must be confined to an approved fume hood operating with a face velocity of at least 100 lfm, or to an approved glove box. Air flow rates on all hoods must be monitored and calibrated annually through OHS; uncalibrated hoods should be reported to the OHS.

Tritium – Individuals involved in operations that use tritium (^3H) in any form other than metallic foil (as in gas chromatography detectors) that are in quantities greater than those listed in Table 2 below must have bioassays performed. Authorized Users must inform the OHS about any workers whose exposure requires periodic bioassay based on these guidelines.

Bioassays for tritium are obtained by urine samples. A baseline sample should be obtained before work with tritium is started. An employee working with quantities exceeding those shown in the table during a single operation shall provide a urine sample within one week after the exposure. An employee who, in one month, works with quantities exceeding those shown in the table shall provide urine samples weekly during the exposure and once after the exposure ends. The OHS may also require urine samples at other times.

Table 2

| Bioassay Levels for Tritium | | | |
|--|--|---|--|
| Processing Done | Tritiated Water or Tritiated Compounds (Ci) | Tritium Gas in Sealed Vessels (Ci) | Tritiated Water Mixed with More Than 10 kg of Inert Water or Other Substances (Ci/kg) |
| In open room with possible escape of tritium | 0.01 (10 MilliCuries) | 10 | 0.001 |
| Within fume hood of adequate design | 0.10 (100 milliCuries) | 100 | 0.010 |
| Within glove boxes | 1.00 (1000 milliCuries) | 1000 | 0.100 |

Tritium oxides (HTO) can be absorbed into the body through the lungs or through the skin; therefore, unsealed sources of tritium should be used only in a certified fume hood. Employees should wear two pairs of protective gloves when working with tritium. Gloves should be changed frequently to prevent the tritium from penetrating over time.

Metal systems should be used when possible to reduce breakage and diffusion through stopcock grease. Laboratory equipment used to process tritium should be considered contaminated. If accidental exposure to tritium occurs, the OHS must be informed immediately. A urine sample or samples from the employee(s) involved must be provided as requested.

Iodine-125 and Iodine 131 – Employees must undergo thyroid monitoring if in one operation or over a 3-month period, they handle open forms of ¹²⁵I or ¹³¹I in quantities which exceed those given in Table 3. For a single operation, monitoring should be done 6 to 72 hours after the exposure; for ongoing exposure to radioiodine, quarterly monitoring is required.

New employees must have baseline thyroid counts measured before beginning work with ¹²⁵I or ¹³¹I. Thyroid monitoring shall also be done when an employee's work with the quantities of radioiodine listed below is completed. Persons whose only radioiodine exposure is through the use of commercial RIA kits should refer to the second column in Table 3 to determine if they need monitoring.

Table 3

| Bioassay Levels for ¹²⁵I and ¹³¹I | | |
|---|---|---|
| | Forms | |
| Processing Done | Volatile or Dispersible (millicurie) | Bound to a Nonvolatile Agent(millicurie) |
| In open room or bench with possible escape from process vessels | 0.1 | 1.0 |
| Within fume hood of adequate design, but with possible escape of iodine | 1.0 | 10.0 |
| Within glove boxes, but with possible leakage or box contamination | 10.0 | 100.0 |

Bioassay requirements for other nuclides (e.g. ³²P) will be determined on a case-by-case basis for those individuals who are likely to receive an intake in excess of 10 percent of the applicable annual limit on intake.

N. LABELING

Definitions:

Restricted area – An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

Unrestricted area – An area access to which is neither limited nor controlled by the licensee.

Radiation area – An area accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

High-radiation area – An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. NOTE: Such an area is unlikely to be created at CDC. The establishment of such an area requires approval by the RSC and the RSO only after a thorough investigation has been made of the need for and the safety of such an area.

Airborne radioactivity area – A room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations –

- (1) In excess of the derived air concentrations (DACs) specified in 10 CFR 20.1001-20.2401, or
- (2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

Labeling Requirements – Each area or laboratory used to store or contain licensed radioactive material shall be conspicuously posted with a door sign bearing the radiation caution symbol and the words "Caution (or Danger), Radioactive Materials." Containers or areas where radioactive material are stored, used and disposed of shall bear a durable, clearly visible label that identifies the contents. The label must have the radiation symbol and the words "Caution (or Danger), Radioactive Materials." Beakers, test tubes, and other glassware that contain radioactive material transiently during an experiment need not be individually labeled. However, containers that will be left unattended must be labeled.

Refrigerators and other containers or areas where radioactive materials are stored must be marked with a radioactive materials label.

A current NRC 3 form "Notice to Employees," must be posted so that it can be easily seen by persons entering or leaving a restricted area. Authorized Users are responsible for posting all signs required and/or provided by the OHS. Authorized Users **must** also **remove signs that are no longer needed** or that have become incorrect or inappropriate for their laboratories.

O. SURVEYS

Active radiation laboratories where radioactive materials are used will be surveyed by Authorized Users or their designee at least once a month by using wipes or a suitable survey meter. A survey using an instrument such as a GM counter is acceptable as long as it is sensitive enough to detect the nuclides used. For low-energy beta emitters such as ³H, ¹⁴C, ³⁵S, or ³³P, contamination surveys should be conducted using wipes, which are counted using a LSC. For ¹²⁵I, a survey instrument equipped with a low-energy sodium iodide crystal is to be used or wipes may be counted on a gamma counter. Review the "Laboratory Surveillance Frequency" chart to determine how often you need to survey your laboratory and "Radiation Safety Due Dates Chart" for dates that Radioisotope Survey Reports are due to OHS.

The results of laboratory surveys will be recorded on CDC form 0.1002, Radiation Survey Report.

A diagram of the laboratory should be made, showing benches, desks, sinks, and hoods; each area tested should be numbered. The wipes or counts from survey instruments should be numbered according to this diagram so that any area that becomes contaminated can be readily identified. Areas tested should be representative of where contamination might be expected (e.g, hoods, sinks, and counter tops), as well as some areas where contamination would not be expected.

In addition to routine surveys, laboratories or other potentially contaminated areas must be surveyed:

1. **After any spill, leak, fire, or other disturbance in a laboratory.**
2. **When work with radioactive materials is terminated.**
3. **Before and after laboratory construction modifications.**
4. **Before maintenance or removal of any equipment that may have come in contact with radioactive material or that contains radioactive material.**

Laboratories with sealed sources will be surveyed at least biannually. The following sealed sources will

be surveyed by the laboratorians, with OHS assistance, for leakage and external contamination at least once every 6 months. The sources will also be surveyed before and after they are moved within a laboratory or to another laboratory, after being dropped or otherwise damaged, and before and after maintenance:

1. Gammacell 220 irradiator.
2. Gas Chromatographs containing a radioactive foil.
3. Any other equipment containing a permanent radioactive source, except Liquid Scintillation Counters.

NOTE: Maintenance, repair, cleaning, replacement, and disposal of GC foils contained in detector cells shall be performed "only" by the device manufacturer. Transfer of GC units or foils off site or on site must be coordinated through the Radiation Safety Section.

| Laboratory Surveillance Frequency | | |
|---|-----------------------|---|
| Survey Category | Activity Range | Survey Frequency |
| Very Low | <0.01 mCi | Once a month |
| Low | 0.01 mCi to 1 mCi | Every 2 weeks (Or more frequently at the discretion of the Authorized User) |
| Medium | >1 mCi to 10 mCi | After each operation |
| High | > 10 mCi | After each operation |
| Modifying Factors | | *Factors |
| Simple storage | | x 0.01 |
| Very simple wet operations (e.g., dilutions of stock solutions, RIA's done with kits) | | x 0.1 |
| Normal chemical operations (e.g., in vitro viral, bacterial, or cell labeling and simple analysis, such as by gel electrophoresis or counting in gamma - or beta counters) | | x 1 |
| Complex wet operations (e.g., radiolabeling of nucleic acids, proteins, etc.:in vitro viral, bacterial, or cell labeling and complex analysis, such as zonal centrifugation or extractions) | | x 10 |
| Simple dry operations (e.g., manipulation of powders) and work with volatile radioactive compounds (e.g., I-125) | | x 10 |
| Exposure of nonoccupational persons | | x 10 |

*The objective is to determine how often to survey the laboratory. To do this, multiply the number of milliCuries of isotope actually used by the appropriate modifying factor to determine the applicable activity range for purposes of surveillance frequency.

EXAMPLE 1: A protein is to be labeled with 1.5 mCi I-125. The modifying factor of 10 multiplied by 1.5 mCi equals 15 mCi or the activity range > 10 mCi. The factor 10 comes from the procedure being classified as a complex wet operation or being classified as work with volatile radioactive compounds. Thus, the laboratory should be surveyed immediately after the labeling procedure.

ALSO NOTE: The laboratorian performing the procedure with I-125 must have a thyroid scan after the operation if the conditions so indicated (see Table 3).

EXAMPLE 2: An in vivo labeled virus preparation containing 500 uCi H-3 uridine to be purified by large-scale separation in a zonal or continuous flow rotor with a rotating seal assembly. This is classified as a complex wet operation. Multiply the number of milliCuries actually used (0.5) by the modifying factor 10 gives an activity range of 5 mCi. This value falls within the 1 mCi to 10 mCi range requiring a survey be performed after each operation with the radioisotope.

Any instrument used for surveys must be calibrated for the specific radioisotope in question at least annually. Calibration curves and records of calibration will be available for all instruments used by radiation workers and OHS. When necessary, the OHS will supply survey instruments to Authorized Users for monitoring radiological procedures.

Action levels for decontamination are shown in Table 4.

Table 4

| Actions Levels for Decontamination Beta and Gamma Emitters | |
|---|--|
| Smear Results | Action |
| 100 dpm/100cm ² | No action required by RSO. Left to discretion of Authorized User. |
| 100-350 dpm/100 cm ² | Area or surfaces should be cleaned as soon as possible by the Authorized User or laboratory personnel. Shoe covers and step-off pads shall be used if contamination is on floor. |
| 350-2,000 dpm/100 cm ² | Contamination should be cleaned immediately under supervision of OHS. Shoe covers and step-off pads are required for entry into area. Only essential personnel will have access. |
| 2,000 dpm/100 cm ² | Air flow should be shut off. Entry of personnel into area should be prevented until a representative of OHS arrives. Cleanup should begin immediately by Authorized user under supervision of RSO. Shoe covers and step-off pads are required. |
| cm ² = square centimeters (100 cm ² = 4" x 4") | |

Cleanup must be undertaken by Authorized Users or laboratory personnel, not by custodial workers.

Every four [4] months, the OHS will perform surveys of laboratories that use radioactive materials as a quality control measure. The Authorized User designee is responsible for making laboratories or other areas accessible for surveys by the OHS.

P. RADIOACTIVE WASTE DISPOSAL

Radioactive waste is any waste that contains or is contaminated with radioactive material. This includes liquids, solids, animals, used scintillation counting liquids (LSC) etc. Consult with OHS in the early planning stages of experiments to develop waste minimization strategies and discuss waste disposal procedures.

Radioactive waste must never be placed in any non-radioactive waste container. The RSO is the only person that can approve any disposal of radioactive via the sink. No general (non-radioactive) waste may be disposed of in radioactive waste containers. Radioactive waste must never be placed in the corridor or any public areas.

All radioactive waste must be labeled with the appropriate label (Radioactive Waste Label) stating the radioisotope name, activity, date of disposal, and the Radiation Worker's full name and telephone number. All individual plastic containers, scintillation vials, bags and bottles of radioactive waste must be tagged with this label. Any information regarding other chemicals included in the radioactive waste must also be included on the form (e.g., strong acid). A Radioactive Waste Disposal Log should be used to compile a list of the radioisotopes disposed of in the waste cans. All of this information is necessary to correctly classify the waste for disposal (radiological, chemical, mixed, etc.).

All radioactive waste containers must be locked and secured. Consult with OHS to obtain appropriate lockable waste and waste storage containers.

Radioactive waste pickup must be scheduled by calling OHS or sending an e-mail requesting the service. The following information is needed to schedule a pickup:

1. Name of Radiation Worker and phone number.
2. Location of waste (building and room number).
3. Type of waste (liquid, solid, carcasses, LSC vials, etc.).
4. Radionuclide(s) in waste.
5. Any special handling instructions.

The OHS will assist Authorized Users in obtaining an appropriate radioactive waste container for each isotope used in the laboratory. Each waste container will be used for disposal of ONE radioisotope ONLY, except for dual labeled radioisotope experiments . Disposal procedures for these containers will be based on the longest half-life. The radioactive waste cans should be stored in an area within the laboratory where they will not be knocked over, used for other waste, or accidentally mistaken as cans for non -radioactive waste. Authorized Users and Radiation Workers are responsible for securing waste until the OHS removes it.

Multi-hazard Waste – This is waste that contains any combination of radioactive, biohazardous, and chemically-hazardous materials known as mixed waste. **Avoid creating such materials, if possible!** Disposal of multi-hazard-waste is extremely costly and difficult.

Solid Waste – This includes test tubes, beakers, absorbent paper, gloves, pipettes, and other dry items contaminated with radioactive material but not containing liquid radioactive waste. This material must be placed in plastic bags, sealed with tape. Hypodermic needles, capillary pipettes, and other sharp objects must be placed in puncture-proof containers before being put into the large waste cans. These puncture proof containers can be obtained from CDC Glassware Supply.

Containers bearing a radioactive label, but no longer containing radioactive material must be disposed of as ordinary waste only after the radioactive label is defaced or removed and after being decontaminated.

Before any radioactive material contaminated with a microbiological organism (virus, fungus, or bacteria) is disposed of, it must be chemically treated in a manner that destroys all living organisms (e.g., with fresh 10 percent bleach solution). Autoclaving or Gammacell irradiation should be used only when necessary. Care should be taken to protect autoclaves from any radioactive contamination, particularly, tritium, and radioiodines.

Before animal experiments with radioisotopes can begin, animal protocols must be approved by the Animal Use Committee and OHS must be consulted so that proper arrangements can be made for disposal of radiologically contaminated or infectious carcasses. Animals that contain less than 0.05 microcurie of ³H or ¹⁴C per gram can be disposed of as biological waste. At concentrations higher than this or for other radioisotopes, the animal or tissues must be disposed of as radioactive waste.

Organic Liquid Waste – Scintillation vials that contain less than 0.05 microcurie of ³H or ¹⁴C per gram of scintillation medium should be disposed of as chemical waste and not as radioactive waste. All scintillation vials containing radioactivity above these levels must be labeled as radioactive waste. Scintillation fluid and radioactive waste must be left in the original vials for disposal. These vials should be placed upright in shipping trays rather than in the large waste cans or plastic bags. Organic solvents that are insoluble, flammable, or toxic must be collected in inert, airtight plastic bottles and must never be disposed of in the sink. The RSO shall oversee the disposal of any aqueous liquid waste that will be picked up from radiation laboratories by Radiation Safety Staff or their representative.

Aqueous Liquid Waste – No liquid radioactive waste shall be disposed of by the sewage system unless (1) the liquid is readily soluble or dispersible in water, and (2) the material is diluted to the concentrations shown in Table 5 or flushed simultaneously with measured amounts of water sufficient to achieve those concentrations (e.g., wash water from glassware that has been used for processing radioactive materials could be disposed of through the sewer).

Table 5*

| Monthly Average Concentration for Releases to Sewer | | |
|---|---------------------------------|--------|
| Isotope | Concentrations (microcuries/ml) | dpm/ml |
| ³ H | 1 x 10 ⁻² | 22200 |
| ¹⁴ C | 3 x 10 ⁻⁴ | 666 |
| ³² P | 9 x 10 ⁻⁵ | 200 |
| ³⁵ S | 1 x 10 ⁻³ | 2200 |
| ⁵¹ Cr | 5 x 10 ⁻³ | 11100 |
| ⁵⁷ Co | 6 x 10 ⁻⁴ | 1332 |
| ¹²⁵ I | 2 x 10 ⁻⁵ | 44 |
| ¹³¹ I | 1 x 10 ⁻⁵ | 22 |

*10 CFR 20, Appendix B, Table 3

Only one sink in each laboratory may be used for disposing of liquid radioactive waste, and it must be appropriately labeled. Disposal of liquid radioactive wastes by sink must be approved by the RSO. After each disposal, the sink shall be flushed with a large amount of water. Authorized Users or Radiation Workers shall keep a record of quantities and isotopes disposed of in this manner and include such disposals on their inventory reports. Chemicals normally treated as hazardous waste cannot be disposed of in this manner. The sink must always be a point of survey when performing decontamination lab surveys.

Liquid radioactive waste must be stored in appropriate containers. RIA kits containing ¹²⁵I should be treated as radioactive waste and will be disposed of by the OHS.

Part 2. Emergency Procedures

EMERGENCY PHONE NUMBERS.

I. Role of the Office of Health and Safety

The Office of Health and Safety (OHS) will investigate all accident, spills, fires, or other incidents in which radiological material is involved. In the event of an accident, the OHS will assist by providing technical advice and by monitoring personnel.

The OHS, through the Radiation Safety Officer (RSO), the Radiation Safety Committee, and the Occupational Health Clinic (OHC), has the responsibility to plan and to arrange emergency medical care for victims contaminated with radioactive material or overexposed to radiation at CDC facilities in metropolitan Atlanta. The OHS will ensure that procedures for emergency care, a list of telephone numbers, and contacts are made available to all Authorized Users.

II. General Emergency Procedures

All users of radioactive materials should be familiar with these procedures **before** any emergency arises.

When an accident involving radioactive materials occurs, address the greatest hazard first. Lifesaving measures always take precedence over decontamination or other concerns. Advise personnel working nearby of any hazard or accident as soon as possible and prevent them entering the hazardous area. Notify OHS at telephone (404) 639-2453 if an incident occurs.

III. Specific Emergency Procedures

A. SPILLS

1. Inform the occupants of the laboratory about the spill.
2. Put on protective clothing, such as shoe covers, and gloves before starting containment and clean up of the spills.
3. Cover the spill with absorbent material as quickly and as completely as possible to prevent spreading. To localize the contamination, wipe inward toward the center of the spill. Do not wipe back and forth or in a random fashion.
4. Have someone who is not contaminated call the OHS immediately.
5. If a biological agent is involved, soak the area with a disinfectant for at least 30 minutes to inactivate the agent, and wash your hands and arms thoroughly with soap or an appropriate disinfectant. Scrub your hands for several minutes and rinse them thoroughly.
6. If you leave the contaminated area, remove your gloves, shoes, and laboratory coat; segregate them as radioactive waste before leaving the laboratory.
7. After removing protective clothing, wash all contaminated areas of skin thoroughly, **without vigorous scrubbing**, with cool water and mild soap for five to ten minutes. Do this as soon as possible after the accident.
8. Remember also to **remove all clothing that may have been contaminated**.
9. Take care not to recontaminate yourself after you have thoroughly washed.
10. Do not leave the area or go to the OHC until someone from the OHS has determined that you have been successfully decontaminated.

B. FIRE

1. Use the following emergency telephone numbers:
 - o **CLIFTON ROAD NOTIFICATION**
 - a. For any fire involving serious injuries, call 9-911. Do not delay. Tell the dispatcher that radioactive materials is involved.
 - b. Business hours, and after hours, call the Clifton Road Security Control Room at telephone (404) 639-2888. The control room will call 9-911.
 - c. Business hours, call the CDC OHS at telephone (404) 639-2453.
 - o **CHAMBLEE NOTIFICATION**
 - a. All hours, call Chamblee Security at telephone (770) 488-4345. Chamblee Security will call 9-911.
 - b. Business hours, call the CDC OHS at telephone (404) 639-2453.
2. Call the OHS.
3. Try to extinguish the fire without risking the safety of personnel.

4. Avoid spreading the contamination.
5. Do not continue work in the laboratory without OHS approval.
6. Again, call 9-911 without delay for any serious injuries. Give as much information as possible regarding the nature of the accident and the injuries that are present. Do not hang up the phone until you are instructed to do so.

C. Explosion

1. **For any accident involving serious injuries, first call 9-911. Do not delay.** Inform the dispatcher that the accident involves radioactive material.
2. Perform any lifesaving and first-aid measure that you can. There may be a significant amount of time before the Hazardous Material (HAZMAT) unit of the Emergency Medical System can get to the accident.
3. Use the following emergency telephone numbers:
 - o **CLIFTON ROAD NOTIFICATIONS**
 - a. Call the Clifton Road Security Control Room at telephone (404)639-2888.
 - b. Call the OHS at telephone (404) 639-2453.
 - c. Call the CDC OHC at telephone (404) 639-3385.
 - o **CHAMBLEE NOTIFICATIONS**
 - a. Call Chamblee Security at telephone (770) 488-4345.
 - b. Call the OHS at telephone (404) 639-2453.
4. Turn off all fume hoods and ventilation where possible.
5. If possible, evacuate the area of the explosion. Restrict contamination to the area by removing your gloves, shoes, and laboratory coats before leaving.
6. Wash all contaminated areas of skin thoroughly, **without vigorous scrubbing**, with cool water and mild soap for five to ten minutes. Do this as soon as possible after the accident.
7. Flush any superficial wound thoroughly with cool water and cover with a sterile dressing.
8. Remember also to **remove all clothing that may have been contaminated.**
9. Take care not to recontaminate yourself.
10. Do not leave the area or go to the OHC until someone from the OHS has determined that you have been successfully decontaminated.

D. Accidents Involving Large Sources

1. If there is any reason to suspect that a large source such as the gamma-cell is unshielded or leaking in any way, you should immediately evacuated all personnel to a safe area.
2. Call the CDC Security Control Room at telephone (404) 639-2888 and call OHS at telephone (404) 639-2453.

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Radiation Safety Committee Charter

STATEMENT OF AUTHORITY AND RESPONSIBILITY
RADIATION SAFETY COMMITTEE CHARTER
RADIATION SAFETY COMMITTEE
CENTERS FOR DISEASE CONTROL AND PREVENTION

The Radiation Safety Committee (RSC) provides for oversight of the CDC Radiation Safety Program to ensure safe use of radioactive material in areas under the control of CDC in all Atlanta facilities. The CDC Radiation Program is the direct responsibility of the Radiation Safety Officer (RSO) of the Office of Health and Safety (OHS). The Director, OHS, reports to the Deputy Director, CDC. The RSC is responsible for formulating policy with regard to radiation safety at CDC and protection of the environment to ensure compliance with Federal regulations, including those of the U.S. Nuclear Regulatory Commission (NRC). The RSC serves as a liaison to all CDC radiation workers in Atlanta. The RSC shall be provided with sufficient authority, organizational freedom, and management prerogative to accomplish these goals. These responsibilities and authorities are limited to the CDC's Radiation Safety Program served under NRC licenses 10-06772-01 and 10-06772-02.

Duties of the RSC

1. Ensures the safe use and security of all radioactive materials and sources of radiation throughout CDC in Atlanta for the Director, CDC.
2. Develops and recommends policies to the Director, CDC, for the control and safe use of radiation sources and to comply with NRC regulations.
3. Reports concerns about the policies and management of the Radiation Safety Program to the Director, CDC. Reports concerns about procedures and daily operations of the Radiation Safety Program to the Director, OHS.
4. Provides technical oversight and advice, and assistance to the OHS on matters concerning radiation safety and security.
5. Receives, reviews, and acts on all new applications for the use of radioactive material or radiation sources in any area used by CDC personnel. Determines that all activities involving radioactive materials and sources of radiation are being conducted safely and in accordance with applicable Federal regulations and CDC radiation safety and security policies.
6. Receives and reviews periodic reports from the OHS on monitoring contamination, personnel monitoring, inspections, and other related radiation safety matters.
7. Reviews and assesses as necessary the overall use of radionuclides and radiation sources used at the CDC for possible modification of possession limits.
8. Reviews all instances of alleged infractions of safety rules and security regulations, and for violations of NRC requirements. Determines the course of corrective action(s) to be taken.

Membership and Organization of the Committee

The Radiation Safety Committee shall be appointed by the Director, CDC. Seven members shall be Authorized Users and shall represent the various types of users of radioactive materials or radiation sources at the various Centers within CDC. In addition to the above seven appointed members, the RSC shall include: 1) the Radiation Safety Officer; 2) the Director, OHS, or his designee (representing CDC management); and 3) an occupational health physician from the Occupational Health Clinic. Members shall serve three-year staggered terms to maintain continuity. The Director, CDC, may choose at her/his discretion to remove or reappoint, at any time, any member of the RSC. The Chairperson and the Secretary of the RSC are elected from the seven standing members, by the members of the RSC and shall serve for 3 years. At least two members must be nominated for each office. In the election of the Chairperson, the nominee who receives the second highest number of votes shall serve as the Vice Chairperson. The Chairperson, Vice Chairperson, and Secretary may continue for additional terms if re-elected with at least two members running for each office. When members are replaced, new appointees shall be chosen to maintain the balance of membership. The RSC may recommend additional members for appointment by the Director, CDC, to enable more effective action of the RSC. Other ex-officio members may also be appointed by the Director, CDC, the Director, OHS, or the RSC Chairperson, as needed.

The Chairperson calls and presides over all meetings, establishes agendas, maintains close communication with the RSO and OHS, and informs the Director, CDC, of important matters related to the Radiation Safety Program. The Chairperson establishes working groups and appoints ex-officio members to the Committee, as the Committee deems necessary. The Vice Chairperson acts as

Chairperson in the absence of the same. The Secretary records and transmits to the RSC minutes of all meetings, and maintains official RSC files. The OHS shall provide administrative support to the Committee. Meetings shall be conducted three times a year at four month intervals. A quorum will be satisfied with half the members plus one, including the chairman or vice chairman, and the RSO or Deputy RSO (his designee).

Appendix B

Radiation Protection Dose Standards

Radiation Dose Limits to Adult Radiation Workers

- 5,000 mrem (50 mSv) per year total effective dose equivalent to the whole body, no one organ of which may exceed 50,000 mrem (500 mSv) per year.
- 15,000 mrem (150 mSv) per year to the lens of the eye
- 50,000 mrem (500 mSv) per year to the skin or to any extremities (hands and forearms, or feet and ankles)

Radiation Dose Limits to Minor (under age 18) Radiation Workers

- 500 mrem (5 mSv) per year total effective dose equivalent to the whole body, no one organ of which may exceed 5,000 mrem (50 mSv) per year.
- 1500 mrem (15 mSv) per year to the lens of the eye
- 5000 mrem (50 mSv) per year to the skin or to any extremities (hands and forearms, or feet and ankles)

Radiation Dose Limits to Members of the General Public

- 100 mrem (1 mSv) per year total effective dose equivalent to the whole body
 - 2 mrem (0.02 mSv) total effective dose equivalent to the whole body per hour
 - 500 mrem (5 mSv) total effective dose equivalent to the fetus of a Declared Pregnant Woman per gestation
-

RADIATION SAFETY DUE DATES

| ACTIVITY | DATE DUE |
|---|----------------------------------|
| RADIOISTOPE INVENTORY REPORT | 1 MAR 1 JUL 1 NOV |
| RADIATION SURVEY REPORT | 1 FEB 1 JUN 1 OCT |
| RADIATION BADGES DISTRIBUTED & COLLECTED | 1 JAN 1 APR 1 JUL 1 OCT |
| GAS CHROMATORGRAPH WIPE TESTS | 1 FEB 1 AUG |
| RADIATION METER CALIBRATION | ONCE/YEAR |
| EACH RADIATION WORKER SHOULD FORWARD THE REPORT(S) THROUGH HIS/HER AUTHORIZED USER TO THE RADIATION SAFETY OFFICE | |

GLOSSARY

Absorbed dose is the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).

Activity is the rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).

Alpha particle is a strongly ionizing particle emitted from the nucleus of an atom during radioactive decay, containing 2 protons and neutrons and having a double positive charge.

Alternate Authorized User serves in the absence of the Authorized user and can assume any duties as assigned. See Part II, Section D for more detail.

Authorized User an employee who is approved by the RSO and RSC and is ultimately responsible for the safety of those who use radioisotopes under his/her supervision. See Part II, Section D for more detail.

Beta particle is an ionizing charge particle emitted from the nucleus of an atom during radioactive decay, equal in mass and charge to an electron.

Bioassay means the determination of kinds, quantities or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

Biological half-life is the length of time required for on-half of a radioactive substance to be biologically eliminated from the body.

Bremsstrahlung is electromagnetic (x-ray) radiation associated with the deceleration of charged particles passing through matter.

Contamination is the deposition of radioactive material in any place where it is not wanted.

Controlled area means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

Counts per minute (cpm) is the number of nuclear transformations from radioactive decay able to be detected by a counting instrument in a one minute time interval.

Curie (Ci) is a unit of activity equal to 37 billion disintegrations per second.

Declared pregnant woman means a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Disintegrations per minute (dpm) is the number of nuclear transformations from radioactive decay in a one minute time interval.

Dose equivalent is a quantity of radiation dose expressing all radiation on a common scale for calculating the effective absorbed dose. The units of dose equivalent are the rem and sievert (Sv).

Dosimeter is a device used to determine the external radiation dose a person has received.

Effective half life is the length of time required for a radioactive substance in the body to lose on-half of its activity present through a combination of biological elimination and radioactive decay.

Exposure means the amount of ionization in air from x-rays and gamma rays.

Extremity means hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

Gamma rays are very penetrating electromagnetic radiations emitted from a nucleus of an atom during radioactive decay.

Half-life is the length of time required for a radioactive substance to lose on-half of its activity by radioactive decay.

Limits (dose limits) means the permissible upper bounds of radiation doses.

Permitted Worker is a laboratory worker who does not work with radioactive materials but works in a radiation laboratory. See Part II, Section F for more detail.

Photon means a type of radiation in the form of an electromagnetic wave.

Rad is a unit of radiation absorbed dose. One rad is equal to 100 ergs per gram.

Radioactive decay is the spontaneous process of unstable nuclei in an atom disintegrating into stable nuclei, releasing radiation in the process.

Radiation (ionizing radiation) means alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions.

Radiation Workers are those personnel listed on the Authorized User Form of the supervisor to conduct work with radioactive materials. See Part II, Section E for more detail.

Radioisotope is a radioactive nuclide of a particular element.

Rem is a unit of dose equivalent. One rem is approximately equal to one rad of beta, gamma, or x-ray radiation, or 1/20 of alpha radiation.

Restricted area means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

Roentgen is a unit of radiation exposure. One roentgen is equal to 0.00025 Coulombs of electrical charge per kilogram of air.

Thermoluminescent Dosimeter (TLD) is a dosimeter worn by radiation workers to measure their radiation dose. The TLD contains crystalline material which stores a fraction of the absorbed ionizing radiation and releases this energy in the form of light photons when heated.

Total Effective Dose Equivalent (TEDE) means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Unrestricted area means an area, access to which is neither limited nor controlled by the licensee.

X-rays is a penetrating type of photon radiation emitted from outside the nucleus of a target atom during bombardment of a metal with fast electrons.

[Health and Safety Manual Contents](#)

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