

RADIATION SAFETY
MANUAL

August 1985

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control
Atlanta, Ga. 30333

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EMERGENCY TELEPHONE NUMBERS

Clifton Road and Chamblee--Ambulance, Fire, Police, 911
Lawrenceville--Fire/Ambulance, 963-0123/963-8154; Police, 962-1900

Employee Health Service Clinic
Bldg. 4, Rm. 121 (8:00 a.m. - 4:30 p.m.)
(404) 329-3385 Commercial, 236-3385 FTS

CDC Office of Biosafety
To report an emergency: (404) 329-3883 Commercial, 236-3883 FTS
After working hours: 329-2888

Emergency Medical Service
Clifton Road: During regular working hours, the Employee Health Service Clinic should be called (ext. 3385) for any emergency treatment. If the Clinic is unable to respond, the employee's supervisor should contact the nearest Emergency Medical Service (EMS) directly. If EMS assistance is requested at the Clifton Road facility, the person requesting this service must also immediately notify the Office of Biosafety (OBS): ext. 3883 during working hours; ext. 2888 during nonworking hours. OBS personnel will meet the EMS team in the lobby and escort the team to the person in need of emergency medical care. During nonworking hours, the person requesting EMS assistance must meet the team at a predetermined location and provide escort and access to controlled areas.

Chamblee and Lawrenceville: The person requesting EMS assistance must meet the team at a predetermined location and provide escort and access to controlled areas.

Radiation Safety Manual

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Preface

These radiation safety guidelines are for Centers for Disease Control 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 can be used as a practical reference, but users should also have technical knowledge of radiation and some experience in handling radioactive materials.

The safety requirements provided in this manual are not comprehensive; radioisotope users must also comply with the safety procedures promulgated by the Office of Biosafety on the use of radioactive materials in the laboratory setting and on general laboratory practices.

Abbreviations Used in This Manual

ALARA	as low a reasonable achievable
CDC	Centers for Disease Control
Ci	curies
CO-60	Cobalt 60
dpm	disintegrations per minute
H-3	hydrogen-3
HTO	tritium oxides
kg	kilogram
lfm	linear feet per minute
mCi	millicuries
mrem	millirems
NRC	Nuclear Regulatory Commission
OBS	Office of Biosafety
RIA	radioimmunoassay
RSC	Radiation Safety Committee
RSO	Radiation Safety Officer
sq cm	square centimeters
TLD	thermoluminescent dosimeter
10 CFR 19	NRC's Rules and Regulations, Title 10, Chapter 1, Part 19 (Appendix A)
10 CFR 20	NRC's Rules and Regulations, Title 10, Chapter 1, Part 20 (Appendix B)

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PART 1. RADIATION SAFETY PROGRAM

I. FEDERAL REGULATIONS

A. Licenses

The Centers for Disease Control (CDC)* operates under two general licenses from the United States Nuclear Regulatory Commission (NRC) and must comply with the terms of each license to continue using any radioisotopes that are produced in a nuclear reactor. Naturally occurring radionuclides, like radium or cyclotron-produced isotopes, are not under the jurisdiction of the NRC. However, since the NRC is authorized to review all radiation safety procedures in any facility that uses by-product materials, its safety standards are also required for natural radionuclides and for x-ray equipment.

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" (Appendix A) and "10 CFR 20" (Appendix B), respectively. 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.

* See the Preface for a list of abbreviations used in this manual.

II. PROGRAM OPERATIONS

A. Administration of the Radiation Safety Program

The Office of Biosafety (OBS) has overall responsibility for occupational safety and health at CDC, including the radiation safety program. The Radiation Safety Officer (RSO) is a member of the OBS staff and serves on the Radiation Safety Committee (RSC). Several other members of the OBS staff, including the Director, may serve as ex officio members of the Committee. The Director, OBS, may act for the RSC and RSO when necessary to control or prevent an incident involving radioactive materials, including ordering cessation of laboratory operations or withholding authority to purchase or use radioisotopes.

Radiation Safety Officer--The RSO is a professional health physicist who provides day-to-day management, oversees the radiation safety program, and assures compliance with policies formulated by the RSC and the Director, OBS. Duties of the RSO include:

1. Consulting with members of the RSC and users of radioactive materials on all matters relating to the use of radionuclides.
2. Assuring compliance with regulations of the NRC and the requirements of the CDC license to procure, use, store, and dispose of radioactive materials.

3. Developing and implementing procedures for periodic radiological surveys of laboratories, monitoring of personnel, handling and disposal of radioactive wastes, and the ordering, receiving, and distribution of radioactive materials.
4. Reviewing protocols for the use of radioactive material submitted by Authorized Users before submission to the RSC.
5. Approving requests to purchase radioactive materials.
6. Maintaining records of procurement, personnel monitoring, accidents and incidents, inventories, and other documents required by the program.
7. Responding to all emergencies involving radioactive materials, providing expert advice and assistance as required to resolve problems.
8. Providing liaison between the OBS and the Employee Health Service Clinic on all matters relating to employee exposure to radiation, monitoring results, etc.

Radiation Safety Committee--The RSC, as required by NRC regulations and the conditions of CDC's NRC license, oversees all operations involving radioactive materials and advises the OBS on matters of radiological safety. Members of the RSC are appointed by the Director, CDC, for a renewable term of 2 years. Duties of the committee include:

1. Reviewing, for approval or rejection, protocols for the use of radioisotopes by Authorized Users.
2. Reviewing and investigating radiation exposures, accidents, and violations of NRC regulations or the policies contained in this manual.

3. Reviewing qualifications and approving Authorized Users of radionuclides.
4. Evaluating the adequacy of facilities in laboratories using or proposing to use radionuclides.
5. Reviewing data or procedures on other aspects of the radiation safety program when requested to do so by the RSO.
6. Suspending authority to use radioactive materials in cases of violations of regulations or other serious deficiencies.

B. "As Low As Reasonably Achievable" (ALARA) Philosophy

The radiation safety program at CDC fully supports the concept that all radiation doses should be "as low as reasonably achievable" (ALARA). This implies that no dose should be acceptable if it can be avoided or is without benefit. Any ALARA program depends on the cooperation of all users of radionuclides at CDC. The program includes the use of proper equipment and procedures to lower radiation exposure. The OBS will investigate any whole-body dose of 125 millirems (mrem) (or 1,875 mrem to the extremities) or more to any individual in any one quarter. If any worker receives a whole-body dose of 375 mrem (or 5,625 mrem to the extremities) or more per quarter, direct actions must be taken to lower any future doses. These actions may require a change in laboratory procedure or an increase in shielding used during current procedures.

The OBS will conduct an annual audit of radiological safety procedures and of the entire ALARA program. The program will be altered as necessary to promote safety and to lower radiation exposure.

C. Authorized Users

All work involving radioactive material must be done under the direction of an approved Authorized User. Each Authorized User is responsible for the safety of those who use radioisotopes under his or her supervision. To become an Authorized User, one must submit a form CDC O.1005, Authorized User Form (Appendix C) to the OBS 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 (Appendix A), 10 CFR 20 (Appendix B), safe radiological procedures, and all related requirements of the OBS. 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. Inform laboratory personnel about correct laboratory procedures when radioisotopes are used and provide enough supervision to see that these procedures are followed.

2. Instruct laboratory personnel in the proper use of personnel monitoring equipment, such as thermoluminescent dosimeters (TLD's), and see that they are worn--if required by OBS--during any procedures involving radioactive materials.
3. Keep complete and accurate records of all radioisotopes received, used, and disposed of, and supply the OBS with this information quarterly or when requested.
4. Assume responsibility for the proper disposal of all radioactive waste.
5. Properly label and secure all radioactive materials from theft or accidental use.
6. Inform the OBS immediately of any spill, fire, explosion, or other accident; any suspected or known overexposure; cessation of work with radioisotopes; and the termination of employment of any laboratory personnel who work with radioisotopes.
7. Assist the OBS in performing surveys, investigating accidents, collecting personnel monitors, and carrying out any other procedures required by regulation or by the radiation safety program.
8. Maintain exposures ALARA through laboratory procedures, shielding, and the use of gloves and other protective clothing.
9. Never transfer radioisotopes to another Authorized User or other personnel without the direct knowledge and consent of the RSO.
10. Conduct a physical inventory every 3 months of all radioisotopes. The OBS requires a signed statement from the Authorized User each quarter stating the location and quantity of each source.
11. Survey the laboratory frequently enough to ensure that it is free of contamination.

2. Instruct laboratory personnel in the proper use of personnel monitoring equipment, such as thermoluminescent dosimeters (TLD's), and see that they are worn--if required by OBS--during any procedures involving radioactive materials.
3. Keep complete and accurate records of all radioisotopes received, used, and disposed of, and supply the OBS with this information quarterly or when requested.
4. Assume responsibility for the proper disposal of all radioactive waste.
5. Properly label and secure all radioactive materials from theft or accidental use.
6. Inform the OBS immediately of any spill, fire, explosion, or other accident; any suspected or known overexposure; cessation of work with radioisotopes; and the termination of employment of any laboratory personnel who work with radioisotopes.
7. Assist the OBS in performing surveys, investigating accidents, collecting personnel monitors, and carrying out any other procedures required by regulation or by the radiation safety program.
8. Maintain exposures ALARA through laboratory procedures, shielding, and the use of gloves and other protective clothing.
9. Never transfer radioisotopes to another Authorized User or other personnel without the direct knowledge and consent of the RSO.
10. Conduct a physical inventory every 3 months of all radioisotopes. The OBS requires a signed statement from the Authorized User each quarter stating the location and quantity of each source.
11. Survey the laboratory frequently enough to ensure that it is free of contamination.

When work with radioisotopes is terminated, the Authorized User must return to the OBS all radioactive material, personnel monitoring badges, and any other issued materials or equipment.

Every 2 years, all Authorized Users must renew their authorization to continue using radioisotopes. If a User does not plan to use radioisotopes within the renewal period, the authorization will be terminated and renewed when authorization is again required.

Authorized Users are responsible for the safety of guest investigators. The OBS must be informed of any guest investigator who wishes to use radioisotopes. The OBS requires the guest to meet the same criteria as other users and assigns an appropriate monitoring badge that must be worn during all procedures involving radioactive materials.

Authorized Users of the gamma-cell irradiator--Personnel using the Cesium-137 (Cs-137) and Cobalt-60 (Co-60) gamma-cell irradiators must do so in the presence and under the supervision of those individuals listed in the license as authorized to use this source.

D. Laboratory Techniques

Although laboratory procedures vary for each radioisotope, the following techniques for handling radioactive materials are essential:

1. Confine radioactive materials to as small an area as possible at all times, especially during any mixing, measuring, or chemical processing.

2. Line the areas where radioactive materials are stored or used with absorbent paper with plastic backing. Change this paper frequently. Work over absorbent paper.
3. Do not store radioisotopes in a fume hood.
4. Do not pipette any radioactive solution by mouth.
5. Always use a hood when working with volatile radioactive solutions.
6. Wear gloves when handling radioisotopes. These gloves must be composed of a material that will prevent the radioisotopes from migrating through them to the skin.
7. Avoid internal exposures. Work procedures and equipment must be designed to prevent the release of any radioactive substance into room air.
8. Maintain ALARA exposures by:
 - Using tongs and shielding where possible.
 - Performing the experiment or the procedure as quickly and as efficiently as possible without increasing the probability of a spill or other accident.
 - Using distance from radioisotopes to lower the dose (for example, stepping away from sources while doing calculations or waiting for a reaction to finish).
9. Wear protective clothing, such as a laboratory coat, during any procedure involving radioactive materials. If there is a possibility that clothing might be contaminated, do not wear this clothing outside the laboratory.
10. Keep the laboratory clean, and segregate radioactive materials and contaminated glassware from other materials and equipment.
11. Never smoke, eat, or drink in work areas where radioisotopes are being used.

12. Wash your hands thoroughly after handling radioisotopes.
13. Label all refrigerators used to store radioisotopes with a radioactive materials caution sign. Never store food in refrigerators containing radioactive materials.
14. Label areas used to store radioisotopes with the radioactive materials caution sign.
15. Label radiation waste containers with an appropriate sign, and store the containers in a secured area when unattended.
16. Assume that all equipment that comes in contact with radioactive materials is contaminated. Do not use such equipment for other purposes or release it for maintenance until it is shown to be free of contamination.

E. 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 beta shield, or lead bricks, when necessary.
3. Remote pipetting devices.
4. Absorbent paper with impervious backing.
5. Appropriate personnel monitoring badges.
6. Labels for doors, hoods, and glassware.
7. Waste containers.
8. Laboratory record book for maintaining inventories.
9. Copy of the CDC Radiation Safety Manual.
10. Appropriate survey meters and materials for conducting wipe samples.

F. Training

All Authorized Users or other personnel under their supervision who work with radioisotopes must receive instruction on radiation safety, biological effects of radiation, regulatory requirements, and laboratory techniques.

At least twice a year, CDC provides a radiation safety course for laboratory personnel who use radioisotopes. Users must complete the radiation safety course before working with radioisotopes. This course includes a discussion of all radiological hazards that workers may encounter, including spills or other incidents.

All persons who frequent restricted areas, such as janitorial workers, secretarial staff, and security personnel, must receive instruction provided by the RSO in accordance with 10 CFR 19.

In accordance with the CDC license requirements, each worker using the Co-60 and Cs-137 sources must meet the requirements outlined above and must be specifically trained in the use of the gamma-cell irradiator.

G. Procurement

Ordering Radioisotopes and Other Radioactive Materials--Only

Authorized Users may order radioisotopes. Radioisotopes are ordered on Form CDC 0.19, Requisition for the Purchase of Services, Supplies, and Equipment. The form must be signed by the Authorized User and sent through the OBS for approval before the material is ordered. The time required for approval will vary with the radioisotope and quantity ordered. The OBS will verify that the order does not violate NRC regulations and that the user is capable of handling the material safely.

If the order is approved, it will be forwarded to the Procurement and Grants Office. If it is disapproved, the reason will be given and the order form will be returned to the Authorized User.

If the material is for a new procedure or process, a complete explanation of how it will be used is required. The OBS will inspect the area where the material will be used and will review the procedure to ensure that safety requirements are met.

The RSC maintains control over certain items that are not by-product materials, such as x-ray equipment. The same procurement procedures described above are followed for these items.

Receiving and Opening Radioactive Packages--All packages containing radioactive materials must be tested by the RSO to determine if the exterior is contaminated and/or if the contents have leaked. If a package is contaminated, the level of contamination will be determined promptly so that the delivering carrier, vendor, and NRC can be notified of the level of contamination. If the package is not contaminated, it will be delivered to the Authorized User after being logged in by the RSO. If a package is delivered without having been checked by the RSO, the Authorized User should contact the RSO immediately.

When a representative from laboratory supply delivers a package containing radioactive materials, a laboratorian must sign for the material on the packing slip. If the Authorized User is not available at the time of delivery, the package may be retained by the representative from laboratory supply.

If an Authorized User opens any radioactive package, including radioimmunoassay (RIA) kits, and discovers that the contents have been spilled or that the container has been broken or cracked, he or she must notify the OBS immediately. The package should be left undisturbed until a representative of OBS arrives.

H. Inventory and Records

The OBS will keep a current inventory of all radioactive materials ordered, received, and disposed of as waste. This inventory is required by NRC and must be as accurate and as up to date as possible.

Authorized Users must keep an account of all radioactive materials. This record must be maintained on form CDC 0.1003, Isotope Inventory (Appendix D), and updated as soon as the radioisotopes are received and used. Authorized Users should send a copy of the inventory to the OBS every four months or upon request. The OBS will provide a form for this inventory report.

Inventory reports must include the quantity of the radioisotopes; and the assay date (date activity was determined). The date of assay is required for accurately determining the exact activity on hand at any date. Authorized Users can either use the date of assay on the original container, or they can "decay correct" the material to the date of the inventory. In both cases, the date to which the activity was corrected (date of assay) must be included on the inventory for each isotope.

I. Personnel Monitoring

Dosimeters--Personal monitoring devices (dosimeters) are required for workers who may receive 25% of the maximum dose of external radiation permissible under NRC's regulations (Table 1). The OBS will also provide dosimeters to persons who work directly with radioisotopes or who work in any laboratory where radioactive materials are used or stored. To apply for a monitoring device, laboratorians must complete form CDC O.871, Request for Radiation Monitoring Badge (Appendix E), and return it to the OBS.

Table 1
Maximum Permissible Dose Equivalent in mrem

<u>Organ</u>	<u>Weekly</u>	<u>Quarterly</u>	<u>Annually</u>
Total body, head and trunk, lens, gonads, blood-forming organs	100	1,250	5,000
Skin of whole body, thyroid	600	7,500	30,000
Hand, forearms, feet, ankles	1,500	18,750	75,000

TLD's will be used for monitoring gamma and high-energy, beta-emitting radioisotopes. They will not be used for monitoring tritium or carbon-14 exposure because they are insensitive to low-energy beta particles. The OBS 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 OBS. Employees must provide information regarding any prior occupational radiation exposure on form CDC 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 OBS so that an accurate record of the worker's total radiation exposure can be maintained.

Employees must wear any dosimeter issued by OBS during any procedure involving radioactive materials and while working in any restricted area. 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 will not be issued dosimeters.

Any dosimeter contaminated or exposed to heat, moisture, or medical x-rays should be returned to the OBS for replacement. After any accident or if an overexposure is suspected, the dosimeters should be returned immediately to the OBS 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. 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 monthly and quarterly through the OBS. The OBS will keep a record of any dose received and will send each worker a copy of his or her exposure record upon request as required by regulation.

Maximum Permissible Doses--Federal limits for radiation doses are provided in Table 1; however, all doses must be maintained ALARA. The OBS will investigate any whole-body dose of 125 mrem (or 1,875 mrem to the extremities) or more per quarter to determine how the exposure was obtained and how future exposures can be avoided. If a whole-body dose of 375 mrem (or 5,625 mrem to the extremities) is received in one quarter, corrective action must be taken to lower any future exposures.

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

When an employee begins or stops working with radiation, the RSO or the RSC may require the employee to have a complete physical examination. The RSC may also require a medical history. Certain bioassays are mandatory for employees and may be requested for others (see section J, "Bioassay").

Internal exposures must be prevented. Respirators are not approved for protection against airborne radioactive material. 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 should be monitored and calibrated at least every 6 months.

J. Bioassay

Tritium--To conform with license requirements, individuals shall have bioassays performed if they are involved in operations that use tritium (hydrogen 3--"H-3") in any form other than metallic foil and in quantities greater than those given in Table 2. Any employee who works with quantities exceeding those shown in the table during a single operation or in 1 month shall provide urine samples within 1 week after exposure or weekly during chronic exposure. The OBS may also require urine samples at other times, for bioassay. An initial bioassay should also be completed before work with these quantities begins.

Table 2
Bioassay Levels for Tritium

<u>Processing Done</u>	<u>Tritiated Water or Tritiated Compounds (Ci)</u>	<u>Tritium Gas in Sealed Vessels (Ci)</u>	<u>Tritiated Water Mixed with More Than 10 kg of Inert Water or Other Substances (Ci/kg)</u>
In open room with possible escape of tritium	0.01	10	0.001
Within fume hood of adequate design	0.10	100	0.010
Within glove boxes	1.00	1,000	0.100

Every employee should have a baseline bioassay performed before and after working with tritium in the forms and quantities given (Table 2). A postwork assay shall be taken within 1 month of the employee's last exposure to tritium (that is, when he or she resigns, transfers, etc.)

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 fume hood. Employees should wear rubber gloves when working with tritium. The gloves should be changed frequently to prevent the tritium from penetrating through them.

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 OBS must be informed immediately. A urine sample or samples from the employee(s) concerned must be provided as requested. Authorized Users must inform the OBS about any workers whose exposure requires periodic bioassay.

Iodine-125 and Iodine-131--Employees must undergo thyroid monitoring if in one operation or over a 3-month period they handle, in an open form, quantities of iodine-125 or iodine-131 that exceed those given in Table 3. For a single operation, monitoring should be done between 6 and 72 hours after the exposure; for chronic exposure, quarterly monitoring is required.

Table 3
 Bioassay Levels for Iodine-125 and Iodine-131

<u>Processing Done</u>	<u>Forms</u>	
	<u>Volatile or Dispersible (mCi)</u>	<u>Bound to a Nonvolatile Agent (mCi)</u>
In open room or bench with possible escape from process vessels	0.1	1
Within fume hood of adequate design, but with possible escape of iodine	1.0	10
Within glove boxes, but with possible leakage or ox contamination	10.0	100

A new employee should have his/her thyroid monitored before beginning work with iodine-125 or -131. Thyroid monitoring shall also be done when an employee's work with the above quantities of radioiodine is ending.

Persons whose radioiodine exposure is through the use of commercial RIA kits exclusively should refer to the second column in Table 3 to determine if they need bioassays.

K. Labeling

Definitions:

Restricted area--any area where access is controlled by the OBS to protect individuals from exposure to radiation or radioactive materials.

Unrestricted area--an area in which a person continuously present could receive no more than 2 mrem of radiation in any 1 hour or 100 mrem in 7 consecutive days.

Radiation area--an area accessible to employees where radiation levels are such that a major portion of the body could receive more than 5 mrem in 1 hour or 100 mrem in 5 consecutive days.

Radiation areas will be marked conspicuously with the radiation insignia and must bear the words "Caution (or Danger), Radiation Area." Such an area shall be locked at all times, with access granted only to individuals approved by the RSO.

High-radiation area--an area in which a major portion of the body could receive 100 mrem in 1 hour. Such an area is unlikely to be created at CDC. The establishment of such an area requires approval by the RSO and the RSC only after a thorough investigation has been made of the need for and the safety of such an area. No high-radiation area will be permitted without this approval.

Airborne radioactivity area--an area where airborne radioactivity exceeds 25% of the amounts specified in 10 CFR 20 (Appendix B) when averaged over the number of hours individuals are present in any 1 week. CDC has no designated airborne radioactivity areas, and none are currently needed. The establishment of an airborne radioactivity area requires the approval of the RSC and RSO after a thorough investigation of the circumstances, the need for such an area, and the requirements for maintaining such an area.

Labeling Requirements--Each area or laboratory used to store or contain licensed radioactive material shall be conspicuously posted with a sign bearing the radiation caution symbol and the words "Caution (or Danger), Radioactive Materials" (Appendix F).

Containers holding radioactive material shall bear a durable, clearly visible label that identifies the contents. The label must have the radiation caution symbol and the words "Caution (or Danger), Radioactive Materials." Each label must also provide the quantity contained, the isotopes, and the date the activity was determined.

Beakers, test tubes, and other glassware that contain radioactive material transiently during an experiment need not be labeled. However, containers that will be left unattended must be labeled according to the rules above.

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

A form NRC 3, "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 OBS. Authorized Users must also remove signs that are no longer needed or that have become incorrect or inappropriate for their laboratories.

LABORATORY SURVEILLANCE FREQUENCY

SURVEY CATEGORY	ACTIVITY RANGE*	SURVEY FREQUENCY
Low	< 1mCi	Every two weeks (or more frequently at the discretion of the Authorized User)
Medium	1mCi to 10mCi	Once a week
High	> 10mCi	After each operation

Modifying Factors

*Factors

Simple storage	x 0.01
Very simple wet operations (e.g., dilutions of stock solutions, RIAs 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 electrol- phoresis 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 centrifuga- tion or extractions)	x 10
Simple dry operations (e.g., manipulation of powders) and work with volatile radio- active compounds (e.g., I-125)	x 10
Exposure of non-occupational persons	x 10

*The object is to determine how often to survey the laboratory. To do this, multiply the number of mCi 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 1.5mCi I-125. The factor 10 multiplied by 1.5 mCi equals 15mCi or the activity range > 10mCi. 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 indicate (see Table 3).

EXAMPLE 2: An in vivo labeled virus preparation containing 500uCi H-3 uridine is to be purified by large-scale separation in a zonal or continuous flow rotor with a rotating seal assemble. This is classified as a complex wet operation. Multiply the number of mCi actually used (0.5) by the modifying factor 10 to determine the applicable activity range, 5 mCi or the medium range, 1mCi to 10mCi. A survey should be performed once per week for this isotope.

L. Surveys

Laboratories where radioactive material is stored or used will be surveyed by Authorized Users at least once a month when radioisotopes are in use by using wipes or a suitable survey meter. The OBS will perform quarterly surveys of laboratories that use radioactive materials. Laboratories with sealed sources will be surveyed at least biannually. Routine surveys for tritium and carbon-14 should be conducted with the wipes method. Other laboratories may be surveyed with a suitable survey instrument. The results of laboratory surveys will be recorded on form CDC 0.1002, Radiation Survey Report (Appendix G).

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 places where contamination might be expected (for example, hoods, sinks, counter tops, note pads, telephone, door handles, soap dishes).

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 completed.
3. before and after laboratory modifications.
4. before maintenance or removal of any equipment that may have come in contact with radioactive material or that contains radioactive material.

The Authorized User is responsible for making laboratories or other areas accessible for surveys by the OBS. Authorized Users must also monitor their own operations regularly to ensure that contamination is not present.

The following sealed sources will be surveyed by the laboratorians, with OBS 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. Gamma-cell 220 irradiator
2. gas chromatographs containing radioactive foil
3. any other equipment containing a permanent radioactive source.

Any instrument used for surveys must be calibrated for the isotope in question every 6 months. Calibration curves and records of calibration will be available for all instruments used by the OBS. When necessary, the OBS will supply survey instruments to Authorized Users for monitoring radiological procedures.

Action levels for decontamination are shown in Table 4.

Table 4
Action Levels for Decontamination
Beta and Gamma Emitters

<u>Smear Results</u>	<u>Action</u>
100 dpm/100 sq cm	No action required by RSO. Left to discretion of Authorized User.
100-350 dpm/100 sq cm	Area or surfaces should be cleaned as soon as possible by the Authorized User or laboratory personnel. Shoe covers and step pads shall be used if contamination is on floor.
350-2,000 dpm/100 sq cm	Contamination should be cleaned immediately under supervision of OBS. Shoe covers and step-off pads are required for entry into area. Only essential personnel will have access.
2,000 dpm/100 sq cm	Air flow should be shut off. Entry of personnel into area should be prevented until a representative of OBS arrives. Cleanup should begin immediately by Authorized User under supervision of RSO. Shoe covers and stop pads are required.

*dpm = disintegrations per minute
sq cm = square centimeters

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

M. Waste Disposal

No radioactive material may be disposed of without the knowledge and consent of the OBS and the RSO. Methods for disposal must be approved before any actual disposal. No radioactive waste will be accepted for disposal by the OBS unless it is labeled with the appropriate isotopic name, activity, date of assay, and date of disposal.

Warehouse Supply will supply Authorized Users with a standardized radioactive waste container for each isotope used in the laboratory. Each container will be used for ONE isotope only. A separate can will be issued for materials contaminated with a mixture of isotopes, and disposal procedures will be based on the longest half-life. The CDC Warehouse will supply plastic bags for lining the waste containers. 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 nonradioactive waste. The area where the waste is stored must be marked with a "Radioactive Waste/Do Not Remove" sign. Authorized Users are responsible for securing waste until the OBS removes it. They can arrange for waste to be picked up by contacting the RSO (ext. 3883). Scheduling should be done in advance to prevent waste overflow. Waste is housed in the radioactive waste storage area adjacent to Building 5 until it is permanently disposed of. Except for OBS personnel, access to this area is prohibited.

All individual bags and bottles of radioactive waste must be marked with a label, form CDC 0.999, Radioactive Waste for Disposal (Appendix H) which includes on it all isotopes, their quantities, date assayed, and physical form. Any chemical information that might be useful should also be included (for example, strong acid). These individual disposal containers must then be placed in the large waste can provided for the particular isotope. Inventory sheets, supplied by OBS, should contain a complete list of the isotopes disposed of in the waste cans.

No radioactive waste will be accepted for disposal if nonradioactive waste or trash is mixed with it. Each bag must be properly labeled, and the inventory form on the top of the container must be complete.

Containers bearing a radioactive label but that no longer contain radioactive material must be disposed of as ordinary trash but only after the radioactive label is defaced or removed.

Solid Waste--Solid waste includes test tubes, beakers, absorbent paper, gloves, pipettes, and other dry items contaminated with radioactive material. 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.

Before any radioactive material contaminated with a biological organism (virus, fungus, or bacteria) is disposed of, it must be autoclaved or chemically treated in a manner that destroys all living organisms. Care should be taken to protect autoclaves from any radioactive contamination.

Before animal experiments with radioisotopes are begun, the OBS 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 hydrogen-3 or carbon-14 per gram can be disposed of as biological waste. At concentrations higher than this or for other isotopes, the animal or tissues must be disposed of as radioactive waste (see Section IIR, Use of Radioactive Materials in Animals).

Organic Liquid Waste--Scintillation vials that contain less than 0.05 microcuries of hydrogen-3 or carbon-14 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.

Solvents that are insoluble, flammable, or toxic must be collected in inert, airtight plastic bottles and must never be disposed of in the sink.

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 (for example, wash water from glassware that has been used for processing radioactive materials could be disposed of through the sewer.)

Table 5*

Concentrations of Radiation Above Natural Background By Isotope

<u>Isotope</u>	<u>Concentrations (microcuries/ml)</u>
Carbon-14	8×10^{-4}
Hydrogen-3	3×10^{-3}
Iodine-125	2×10^{-7}
Iodine-131	3×10^{-7}
Nickel-63	3×10^{-5}
Phosphorus-32	2×10^{-5}
Sulfur-35	6×10^{-5}

*10 CFR 20, Appendix B, Table II, col. 2

Only one sink in each laboratory shall be used for disposing of liquid radioactive waste, and it shall be appropriately labeled. After each disposal, the sink shall be flushed with a large amount of water. Authorized Users 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.

Liquid radioactive waste must be stored in unbreakable, airtight bottles or in double containers with enough absorbent material in the outer container to absorb any spillage. RIA kits containing I-125 should be treated as radioactive waste and will be disposed of by the OBS.

N. Cobalt-60 and Cesium-137 Irradiators

Only persons listed on the NRC license as users shall operate the gamma-cell irradiators without personal supervision. All others must have one of the listed Authorized Users present. The room housing the irradiators must be locked at all times, and a TLD must be worn when the gamma-cell is used. Each user must also sign and date a logbook before using the irradiators. All notices from NRC concerning the gamma-cell irradiators must be provided to each user.

Each gamma-cell will be tested for contamination and leakage at least once every 6 months by a contract vendor. This test must be capable of detecting 0.05 microcurie of contamination. If 0.05 microcurie of removable contamination is found, the gamma-cell will be removed from operation immediately.

0. Gas Chromatography Detectors

All gas chromatography units containing radioactive material must be used under the direction of OBS. These sources are subject to the same regulations as other radioactive material at CDC, and the following requirements must be satisfied for each unit:

1. Each piece of equipment must be marked with a radioactive label identifying the isotope, quantity, and assay date.
2. Radioactive foils must not be removed from their cells or transferred to another chromatograph.
3. Chromatographs must be done on absorbent paper, in a hood. Gloves must be worn during cleaning operations.
4. Units with titanium or scandium tritide foil must be used with a properly operating temperature control mechanism to prevent the foil temperature from exceeding 325°C.
5. All new equipment or newly repaired chromatographs must be leak tested by the laboratorian before being operated.
6. Gas chromatography units with radioactive foils must be vented into a fume hood or room exhaust with plastic tubing to prevent work areas from being contaminated.
7. Units must be operated according to manufacturers' instructions.
8. Authorized Users of gas chromatographs with radioactive material are responsible for the security of the source. The equipment or source must not be moved to another location or transferred to another user without permission from the OBS.
9. The OBS must be informed of any radioactive foil that is no longer in use.

9-10-85

Paul Simpson
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condition on license.
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Each chromatograph will be tested for leakage every 6 months by the laboratorians, with the assistance of OBS. Alpha emitters will be tested every 3 months by the Authorized Users, and records of testing must be sent to OBS. Test wipes must be made from the surface of the device where the foil is mounted, according to instructions enclosed with the chromatographs. The radiation detector and the method used for testing must be capable of detecting 0.005 microcurie of contamination. If 0.005 microcurie or more of contamination is detected, the unit must be immediately withdrawn from use.

P. X-ray Equipment

Only Authorized Users will be permitted to use x-ray-producing equipment. These Authorized Users must meet the same general requirements and will have the same responsibilities as other Authorized Users of radioactive materials. All applicable sections of the Radiation Safety Manual must be followed. The following is a partial list of requirements:

1. Process all orders for x-ray equipment through the RSO.
2. Complete an Authorized User form and wait for the request to be approved before using the equipment.
3. Obtain RSC approval for the location of the machine and the operating procedures before using it.
4. If the x-ray beam is not fixed in position, check and record its alignment quarterly. Realign, if necessary.
5. Enforce security precautions stringent enough to prevent any nonauthorized personnel from using the equipment at any time.

6. Test safety interlocks every 6 months to see that they are functional.
7. Follow guidelines provided by the RSO for the specific conditions under which the x-ray equipment is used.
8. Authorized Users must meet the requirements established by the OBS.

Q. Radioactive Phosphorus

Phosphorus-32 emits high-energy beta radiation. Shielding for this type of radiation should be composed of a material with a low atomic number such as plastic or plexiglass. Phosphorus shall be stored and disposed of in plastic containers and must be kept cool at all times.

R. Use of Radioactive Materials in Animals

Before animal experiments with radioisotopes are begun, the OBS must be consulted so that proper arrangements can be made for disposal of radiologically contaminated or infectious carcasses.

Radioisotopes must be administered to animals over an absorbent material that can be easily removed if contaminated. Cages housing these animals must be labeled with the isotope, quantity injected per animal, and necessary precautions (if isotope is eliminated in feces, care should be taken with waste material). These cages should be segregated from other cages, if possible. Animal excreta may be disposed of by sewer if the concentrations do not exceed those shown in Table 5. If concentrations are likely to be above this level, the waste should be bagged and handled as solid radioactive waste. Animal carcasses containing less than 0.05 microcurie of hydrogen-3 or

carbon-14 per gram can be disposed of as biological waste. Carcasses with higher concentrations or containing other isotopes must be disposed of as radioactive waste. Carcasses or tissues should be frozen in a plastic bag and labeled with a radioactive decal that includes species, isotope, and quantity, and they should remain frozen until permanent disposal is available.

All workers handling the animals must be informed of necessary procedures and safety measures. If the radioactive material is capable of being volatilized after the animal is infected--for example, through exhaled air--proper ventilation must be provided to ensure that radioactive material does not accumulate in room air.

PART 2. EMERGENCY PROCEDURES

See inside front cover for emergency phone numbers.

I. GENERAL PROCEDURES

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

When an accident involving radiation 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 from entering the hazardous area. Always notify the Office of Biosafety (OBS) (ext. 3883) when an accident occurs.

II. OFFICE OF BIOSAFETY

The OBS will investigate all accidents, spills, fires, or other incidents in which radiological material is involved. In the event of an accident, the OBS will assist by monitoring personnel and cleanup procedures and by providing technical advice.

The OBS, through the Radiation Safety Officer (RSO) and the Radiation Safety Committee (RSC), 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 OBS will ensure that procedures for emergency care and a list of phone numbers and contacts are made available to all Authorized Users.

III. SPECIFIC PROCEDURES

A. Explosion

1. If an explosion occurs, assume that the entire laboratory is contaminated.
2. Perform any possible lifesaving measures that are needed.
3. Call the OBS immediately, or have someone call for you. Inform the OBS of any injuries, particularly life-threatening conditions.
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 your hands and arms thoroughly with a mild soap for several minutes, and rinse them thoroughly with cool water.
7. If you or other personnel have superficial wounds, flush the wounds with water and cover them with clean, sterile material. Seek medical attention at the Employee Health Service Clinic.
8. Do not attempt to clean up without the supervision of a representative from the OBS
9. Do not continue work in the laboratory without OBS approval.

B. Fire

1. Call the fire department from a safe place, and identify the location of the fire.
2. Call the OBS.
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 OBS approval.

C. Spills

1. Inform the occupants of the laboratory about the spill.
2. 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.
3. Have someone who is not contaminated call the OBS immediately.
4. Remove shoes, gloves, and laboratory coat before you leave the laboratory.
5. Wait for a representative of OBS before attempting any cleanup.
6. If at all possible, do not touch objects or people before being checked for contamination.
7. If a biological agent is involved, soak the area with a disinfectant for 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.
8. If you leave the contaminated area, remove your gloves, shoes, and laboratory coat; segregate them as radioactive waste before leaving the laboratory.

9. If toxic or radioactive fumes are generated outside the hood, turn on all fume hoods.
10. Do not continue using the laboratory without OBS approval.

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 evacuate all personnel to a safe area.
2. Call the OBS.
3. Have any person who may have been exposed remain in a safe area until an OBS representative arrives.

Bibliography

International Commission on Radiological Protection. The principles and general procedures for handling emergency and accidental exposure to workers; Publication 28. Elmsford, New York: Pergamon Press, 1978.

U.S. Nuclear Regulatory Commission, Washington, D.C. Nuclear Regulatory Guides:

- 8.10 Operating philosophy for maintaining occupational exposures as low as reasonably achievable, 1975.
- 8.20 Applications of bioassay for I-125 and I-131, 1979.
- 8.13 Instruction concerning prenatal radiation exposure, 1975.
- 8.29 Instruction concerning risks from occupational radiation exposure, 1981.

Shapiro, J., Radiation protection. 2nd ed. Cambridge, Massachusetts: Harvard Univ. Press, 1981.

UNITED STATES NUCLEAR REGULATORY COMMISSION

RULES and REGULATIONS

TITLE 10, CHAPTER 1, CODE OF FEDERAL REGULATIONS—ENERGY

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PART 19

NOTICES, INSTRUCTIONS, AND REPORTS TO WORKERS; INSPECTIONS

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19.2 Scope.
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19.20 Violations.
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19.32 Discrimination prohibited.

Authority: Secs. 53, 63, 81, 103, 104, 181, 186, 66 Stat. 930, 933, 936, 937, 948, 953, as amended; sec. 234, 53 Stat. 444, as amended (42 U.S.C. 2073, 2083, 2111, 2133, 2134, 2201, 2236, 2282); sec. 201, 86 Stat. 1242, as amended by Pub. L. 94-79, 86 Stat. 413 (42 U.S.C. 5841); Pub. L. 95-601, sec. 10, 92 Stat. 2951 (42 U.S.C. 5851).

For the purposes of sec. 223, 66 Stat. 958, as amended (42 U.S.C. 2273); §§ 19.11(a), (c), (d), and (e) and 19.12 are issued under sec. 181b, 66 Stat. 948, as amended (42 U.S.C. 2201(b)); and §§ 19.13 and 19.14(a) are issued under sec. 181c, 66 Stat. 950, as amended (42 U.S.C. 2201(c)).

§ 19.1 Purpose.

The regulations in this part establish requirements for notices, instructions, and reports by licensees to individuals participating in licensed activities, and options available to such individuals in connection with Commission inspections of licensees to ascertain compliance with the provisions of the Atomic Energy Act of 1954, as amended, Title II of the Energy Reorganization Act of 1974, and regulations, orders, and licenses thereunder regarding radiological working conditions.

§ 19.2 Scope.

➤ The regulations in this part apply to all persons who receive, possess, use, or transfer material licensed by the Nuclear Regulatory Commission pursuant to the regulations in Parts 30 through 35, 40, 60, 61, 70 or 72 of this chapter, including persons licensed to operate a production or utilization facility pursuant to Part 50 of this chapter and persons licensed to possess power reactor spent fuel in an independent spent fuel storage installation (ISFSI) pursuant to Part 72 of this chapter.

§ 19.3 Definitions.

As used in this part:

- (a) "Act" means the Atomic Energy Act of 1954, (68 Stat. 919) including any amendments thereto;
(b) "Commission" means the United States Nuclear Regulatory Commission;
(c) "Worker" means an individual engaged in activities licensed by the Commission and controlled by a licensee, but does not include the licensee.
(d) "License" means a license issued under the regulations in Parts 30 through 35, 40, 60, 61, 70 or 72 of this chapter, including licenses to operate a production or utilization facility pursuant to Part 50 of this chapter and licenses to possess power reactor spent fuel in an independent spent fuel storage installation (ISFSI) pursuant to Part 72 of this chapter. "Licensee" means the holder of such a license.

(e) "Restricted area" means any area access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. "Restricted area" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area.

§ 19.4 Interpretations.

Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.

§ 19.5 Communications.

Except where otherwise specified in this part, all communications and reports concerning the regulations in this part should be addressed to the Director, Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555. Communications, reports, and applications may be delivered in person at the Commission's offices at 1717 H Street, NW., Washington, D.C.; or at 7920 Norfolk Avenue, Bethesda, Maryland.

§ 19.11 Posting of notices to workers.

(a) Each licensee shall post current copies of the following documents: (1) The regulations in this part and in Part 20 of this chapter; (2) the license, license conditions, or documents incorporated into a license by reference, and amendments thereto; (3) the operating procedures applicable to licensed activities; (4) any notice of violation involving radiological working conditions, proposed imposition of civil penalty, or order issued pursuant to Subpart B of Part 2 of this chapter, and any response from the licensee.

(b) If posting of a document specified in paragraph (a) (1), (2) or (3) of this section is not practicable, the licensee may post a notice which describes the document and states where it may be examined.

(c) Each licensee and applicant shall post Form NRC-3, (Revision 6-82 or later) "Notice to Employees," as required by Parts 30, 40, 50, 60, 70, 72, and 150 of this chapter.

(d) Documents, notices, or forms posted pursuant to this section shall appear in a sufficient number of places to permit individuals engaged in licensed activities to observe them on the way to or from any particular licensed activity location to which the document applies, shall be conspicuous, and shall be replaced if defaced or altered.

(e) Commission documents posted pursuant to paragraph (a) (4) of this section shall be posted within 2 working days after receipt of the documents from the Commission; the licensee's response, if any, shall be posted within 2 working days after dispatch by the licensee. Such documents shall remain posted for a minimum of 5 working days or until action correcting the violation has been completed, whichever is later.

§ 19.12 Instructions to workers.

All individuals working in or frequenting any portion of a restricted area shall be kept informed of the storage, transfer, or use of radioactive materials or of radiation in such portions of the restricted area; shall be instructed in the health protection problems associated with exposure to such radioactive materials or radiation. In precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed; shall be instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of Commission regulations

UNITED STATES NUCLEAR REGULATORY COMMISSION RULES and REGULATIONS

TITLE 10, CHAPTER 1, CODE OF FEDERAL REGULATIONS—ENERGY

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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PART 20

PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

GENERAL PROVISIONS

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APPENDIX C

APPENDIX D—UNITED STATES NUCLEAR REGULATORY COMMISSION, INSPECTION AND ENFORCEMENT REGIONAL OFFICES

AUTHORITY: Secs. 53, 63, 65, 81, 103, 104, 161, 68 Stat. 930, 933, 935, 936, 937, 946, as amended; 42 U.S.C. 2073, 2093, 2095, 2111, 2133, 2134, 2201. For the purposes of sec. 223, 68 Stat. 958, as amended; 42 U.S.C. 2273, (1) 20.401-20.408, issued under sec. 1610, 68 Stat. 950, as amended; 42 U.S.C. 2201(c). Secs. 202, 206, Pub. L. 93-438, 88 Stat. 1244, 1246 (42 U.S.C. 5842, 5846), unless otherwise noted.

SOURCE: 25 FR 10914, Nov. 17, 1960, unless otherwise noted.

NOMENCLATURE CHANGES 40 FR 8783, Mar. 3, 1975, 45 FR 14200, Mar. 5, 1980.

GENERAL PROVISIONS

§ 20.1 Purpose.

(a) The regulations in this part establish standards for protection against radiation hazards arising out of activities under licenses issued by the Nuclear Regulatory Commission and are issued pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974.

(b) The use of radioactive material or other sources of radiation not licensed by the Commission is not subject to the regulations in this part. However, it is the purpose of the regulations in this part to control the possession, use, and transfer of licensed material by any licensee in such a manner that the total dose to an individual (including exposures to licensed and unlicensed radioactive material and to other unlicensed sources of radiation, whether in the possession of the licensee or any other person, but not including exposures to radiation from natural background sources or medical diagnosis and therapy) does not exceed the standards of radiation protection prescribed in the regulations in this part.

(c) In accordance with recommendations of the Federal Radiation Council, approved by the President, persons engaged in activities under licenses issued by the Nuclear Regulatory Commission pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974 should, in addition to complying with the requirements set forth in this

part, make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable. The term "as low as is reasonably achievable" means as low as is reasonably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest.

§ 20.2 Scope.

The regulations in this part apply to all persons who receive, possess, use, or transfer material licensed pursuant to the regulations in Parts 30 through 35, 40, 60, 70, or 72 of this chapter, including persons licensed to operate a production or utilization facility pursuant to Part 50 of this chapter and persons licensed to possess power reactor spent fuel in an independent spent fuel storage installation (ISFSI) pursuant to Part 72 of this chapter.

§ 20.3

§ 20.3 Definitions.

(a) As used in this part:

- (1) "Act" means the Atomic Energy Act of 1954 (68 Stat. 919) including any amendments thereto;
- (2) "Airborne radioactive material" means any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors, or gases;
- (3) "Byproduct material" means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material;

(4) "Calendar quarter" means not less than 12 consecutive weeks nor more than 14 consecutive weeks. The first calendar quarter of each year shall begin in January and subsequent calendar quarters shall be such that no day is included in more than one calendar quarter or omitted from inclusion within a calendar quarter. No licensee shall change the method observed by him of determining calendar quarters except at the beginning of a calendar year.

APPENDIX C

AUTHORIZED USER FORM

1. Authorized User's Name _____
Title _____
Center _____ Division _____ Branch _____
Section _____
Mailing Address _____
Phone _____
2. Alternate's Name (appointed to supervise workers and order radioisotopes in absence of Authorized User) _____
Mailing Address _____
Phone _____
3. Check one:
☐ New Authorized User
☐ Current Authorized User - update
☐ Amendment to current authorization
4. Location, building, and room numbers where radioactive materials will be used and/or stored _____

will be stored pending disposal or decay _____

5. How will security of materials be maintained?
____ Materials will be stored in a locked cabinet, refrigerator, or freezer
____ Room will be locked when unattended
____ Room has Cardkey access only
____ Other (specify) _____

6. Radioactive Materials Required

Radioisotope	Chemical Form(s)	Physical Form	Maximum Order	Maximum on Hand
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

7. Will animals be used in your radioisotope program? _____ No _____ Yes

If yes, explain procedure for use and disposal. _____

8. Outline procedures for use of each radioisotope, including amounts and any equipment used, and frequency of the procedures. Use separate sheets as necessary and attach any written protocols that are available.

9. Describe the safety procedures used for each radioisotope (hood, shielding, etc., for use and storage). _____

10. What methods do you intend to employ for disposing of your radioactive waste? Indicate whether your response pertains to solid (S), liquid (L), or gaseous (G) waste by writing the appropriate letter(s) beside each applicable method.

_____ Consolidation (by isotope) and proper packaging, etc., for pickup by the Office of Biosafety. For liquid waste only please estimate total volume generated in a specific time interval

_____ Decay

_____ Dilution to acceptable concentration limits and disposal to the sewer/atmosphere. How will airborne releases be assessed and controlled? (specify) _____

_____ Other (specify) _____

_____ Waste generation not anticipated

11. At what frequency will your radioisotope facilities be surveyed by you?

_____ After any spill, leak, fire, or other disturbance in the lab

_____ After labelling procedures

_____ Monthly (unsealed sources)

_____ Quarterly (sealed sources only)

_____ Semiannually (permitted for rooms in which $>200 \mu\text{Ci}$ is in use at any one time or if isotopes are stored only)

_____ Other (specify) _____

12. Which of the following will be used to perform surveys?

_____ Wipe tests and liquid scintillation counting (^{14}C and ^3H)

_____ Survey meter model(s) _____

to be calibrated by:

_____ Office of Eicsafety _____ Other

_____ Other (specify) _____

13. Authorized User's Training and Experience

Type of Training	Where	Dates	On the job or formal course (title)
A. Principles and practices of radiation protection			
B. Radioactivity measurement, standardization and monitoring techniques and instruments			
C. Calculations basic to the use and measurement of radioactivity			
D. Biological effects of radiation			

Experience

Radioisotope/Maximum quantity	Where	Dates	Type of Use

14. Alternate's Training and Experience

Type of Training	Where	Dates	On the job or formal course (title)
A. Principles and practices of radiation protection			
B. Radioactivity measurement, standardization and monitoring techniques and instruments			
C. Calculations basic to the use and measurement of radioactivity			
D. Biological effects of radiation			

Experience

Radioisotope/Maximum quantity	Where	Dates	Type of Use

15. Describe the training or instruction you will provide or require for all personnel who will work with or in the vicinity of radioisotopes used under your authorization.

a. _____ Personnel will be required to read CDC Radiation Safety Manual.

b. _____ Other (explain in detail) _____

16. List personnel who will be using each radioisotope.

1. _____
2. _____
3. _____
4. _____

17. List and describe any radiation detectors present in your laboratory or available for your use (gamma counters, liquid scintillation counters, etc.)

1. _____
2. _____
3. _____
4. _____

18. On a separate sheet, diagram all labs where radioisotopes are used or stored, and where waste is stored. Include all doors, hoods, sinks, desks, cabinets, and benches. Mark where sources will be used and stored.

19. I understand my responsibilities as an Authorized User and agree to meet the requirements of the Radiation Safety Program.

Signature _____ Date _____

ISOTOPE INVENTORY
(PRIVACY ACT STATEMENT ON REVERSE)

Authorized User's Name _____

Center _____ Division _____ Branch _____

Section _____ Phone _____

*Report activity in mCi

Inventory preparer: _____

Date of Inventory: _____

APPENDIX E

REQUEST FOR RADIATION MONITORING BADGE (PRIVACY ACT STATEMENT ON REVERSE)

As required by Title 10, Chapter 1, Part 19, Code of Federal Regulations, U.S. Nuclear Regulatory Commission, the following information regarding your past work related radiation exposure is necessary for issuance of a monitoring badge. Fill in the blanks, sign, and return to the Office of Biosafety, Building 4, Room 232.

AUTHORIZED USER NAME _____

FULL NAME _____ PHONE _____

DATE OF BIRTH _____ BLDG/RM _____

SOCIAL SECURITY NUMBER _____

JOB TITLE _____

PREVIOUS EDUCATIONAL/EMPLOYMENT RECORD INVOLVING WORK WITH RADIOACTIVE MATERIALS:

NAME _____

ADDRESS _____

DATE: FROM _____ TO _____

NAME _____

ADDRESS _____

DATE: FROM _____ TO _____

NAME _____

ADDRESS _____

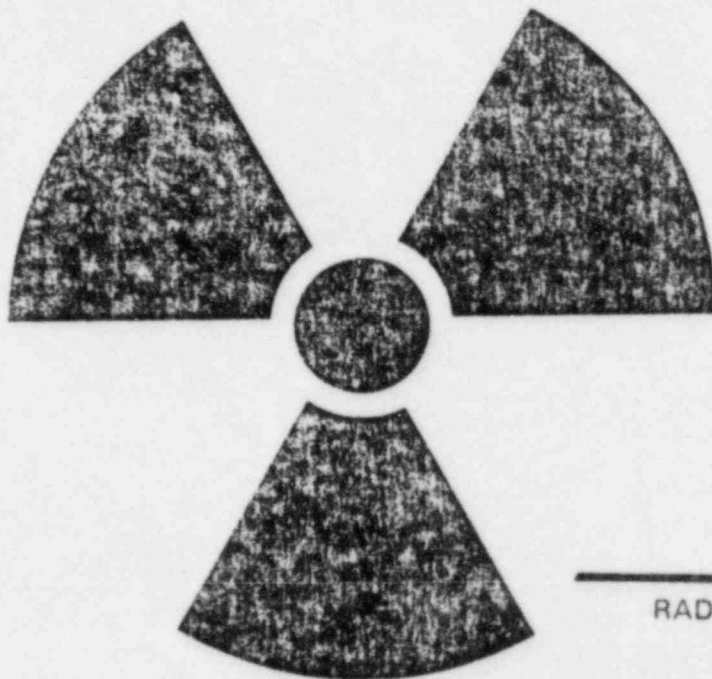
DATE: FROM _____ TO _____

I authorize release of all my radiation exposure history as listed above.

Signature

Date

CAUTION



RADIOISOTOPES

RADIOACTIVE MATERIALS

IN EMERGENCY CALL

AUTHORIZED USER

RADIATION SAFETY OFFICER

SECURITY GUARDS

NAME

TELEPHONE

INSTRUCTIONS:

Engineering personnel should clear with the Radiation Safety personnel before making alteration or repair on hoods and ducts, plumbing, etc.

Janitors may work in this room with safety unless otherwise indicated. Do not touch any item labeled RADIOACTIVE.

NOTICE:

This sign must be displayed prominently in all areas and at all sites where radioactive materials are stored and used.

APPENDIX G

RADIATION SURVEY REPORT

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
ATLANTA, GEORGIA 30333

Authorized User No.			
Authorized Investigator	Telephone No.	Organization	Date
Surveyor	Telephone No.	Building/Room No.	Radionuclides Used

COUNTING EQUIPMENT

L.S.C. — EFF — %
GAMMA — EFF — %

SMEAR SURVEY RESULTS

SAMPLE NO.	LOCATION	CPM NUCLIDE	SAMPLE NO.	LOCATION	CPM NUCLIDE

COMPLIANCE ITEMS

Room and Storage Posted	<input type="checkbox"/>	Personnel Monitoring	<input type="checkbox"/>
Inventory, Disposal Records Adequate	<input type="checkbox"/>	Personnel Training	<input type="checkbox"/>
Containers & Equipment Labeled	<input type="checkbox"/>	Survey Records	<input type="checkbox"/>
Waste Handling Practices	<input type="checkbox"/>	Shielding	<input type="checkbox"/>
Hoods and Ventilation	<input type="checkbox"/>	Other	<input type="checkbox"/>
Survey Instruments	<input type="checkbox"/>		

COMMENTS

AREA DIAGRAM AND SAMPLING SITES

APPENDIX H

LABEL FOR RADIOACTIVE WASTE DISPOSAL

RADIOACTIVE WASTE FOR DISPOSAL

INSTRUCTIONS: Firmly attach this label to each container of radioactive waste. Provide sufficient information to fully identify contents. Call Radiation Safety Officer (3883) for additional information.

BLDG _____ RM. _____

INVESTIGATOR: _____

TELEPHONE: _____

RADIOISOTOPE
NAME: _____

ACTIVITY: _____

DATE OF
DISPOSAL: _____

DATE OF ASSAY: _____

CDC 0.999 2-85