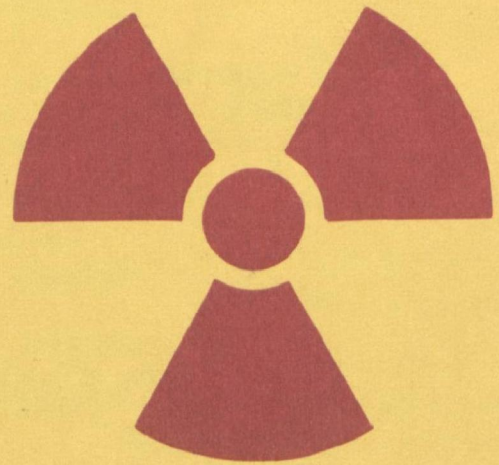


RADIATION SAFETY MANUAL

**U.S. ENVIRONMENTAL
PROTECTION AGENCY
CINCINNATI, OHIO**



EMERGENCY PROCEDURES FOR RADIATION ACCIDENTS

1. Survey and then evacuate possibly exposed personnel from accident area and give urgent first aid.
2. Notify: Medical Telephone 684-7283
Health Physics (Industrial Hygiene) Telephone 684-7269
Your Laboratory Supervisor Telephone _____
3. Close off radiation area. Turn off air supply. Seal area if contamination is likely.
4. Confine and survey all contaminated people. Then give first aid for traumatic injury and burns.
5. Evaluate situation in regard to: Contamination by radionuclides
Neutron exposure
Level of radiation exposure.
6. If contamination is present, perform simple decontamination and resurvey patient.
7. Save all samples of clothes, jewelry, blood, urine, stool, vomitus. Label with name, time, date.
8. Obtain careful history of accident.
9. Send patient to hospital if exposure of 100 R or more is suspected.
10. Obtain: names, addresses, and telephone numbers of all witnesses.

IN CASE OF SUSPECTED OR ACTUAL EMERGENCY

CALL

Your Supervisor _____ Telephone: Day _____
Night _____

AND

RADIATION SAFETY OFFICER Telephone: Day 684-7269
George A. Bodmer Night 732-2844

AND

DEPUTY RADIATION SAFETY OFFICER Telephone: Day 872-4115
Kenneth M. Fritz, M.S.* Night 825-9110

CHAIRMAN, RADIATION SAFETY COMMITTEE Telephone: Day 684-7429
James B. Lucas, M.D. Night 781-3580

JUN 27 1968
* If no answer call other persons listed on the following page.

RADIATION SAFETY OFFICER AND DEPUTY

George A. Bodmer, Safety Officer
Ext. 7269
Home Address: 1936 Eiklick Road
Batavia, Ohio 45103
Home Phone: 732-2844

Deputy: Kenneth M. Fritz, M.S.
Radioisotope Laboratory
Cincinnati General Hospital
872-4115 or 872-4282
Home Address: 2515 Owlcrest Drive
Cincinnati, Ohio 45231
Home Phone: 825-9110

DEPUTY RADIATION SAFETY OFFICERS IN CASE OF ACCIDENT

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Radioisotope Laboratory
Cincinnati General Hospital
872-4115 or 872-4282
Home Address: 2482 Queen City Avenue
Cincinnati, Ohio 45238
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Robert E. Peterson, Jr., B.S.
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Home Address: 1922 Westwood Northern Blvd.
Cincinnati, Ohio 45225
Home Phone: 662-5806

Eugene L. Saenger, M.D.
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Cincinnati General Hospital
872-4282
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Cincinnati, Ohio 45243
Home Phone: 793-1373

ENVIRONMENTAL RESEARCH CENTER RADIATION SAFETY COMMITTEE

James B. Lucas, M.D. (Chairman)
Health Effects Research Laboratory
Cincinnati - 684-7429

Eugene L. Saenger, M.D. (Associate Chairman)
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Cincinnati General Hospital - 872-4282

Gary S. Logsdon, Ph.D.
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Health Effects Research Laboratory
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Environmental Monitoring & Support Laboratory
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Cincinnati General Hospital - 872-5476

U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO

RADIATION SAFETY MANUAL

March 1977

George A. Bodmer
Radiation Safety Officer

Kenneth M. Fritz, M.S.
Deputy Radiation Safety Officer

James B. Lucas, M.D.
Chairman, Radiation
Safety Committee

Eugene L. Saenger, M.D.
Vice Chairman, Radiation
Safety Committee

PREFACE

This radiation manual is designed to facilitate the safe use of radiation sources of various types, generators and radioactive nuclides, within the Environmental Protection Agency-Cincinnati. The Radiation Safety Committee is charged with the responsibility of radiation safety for investigators, technicians, maintenance personnel and the general public. It is not concerned with the quality of scientific work.

It is the hope of our Committee that this manual will aid and encourage the use of radiation as a method for research and training. The members of the Committee are available for help and consultation at any time. If certain regulations seem restrictive, one should realize that these requirements are dictated by considerations of health and safety and by the rules of the U.S. Nuclear Regulatory Commission (NRC), and the EPA Radiological Health and Safety Program. We are proud of the fact that we possess a broad general license which permits the EPA-Cincinnati to obtain almost all radioisotopes with the approval of the Radiation Safety Committee. All of us bear equal responsibility for the operation of a safe program so that our broad license can continue.

Individuals planning to work with radionuclides under the broad license of the EPA-Cincinnati are required to submit the form "Certification for Use of Radiation" before beginning work (See Appendix A, Form EPA-294).

Each user of radiation is required to read this manual and be familiar with its contents according to the Code of Federal Regulations (10CFR20). The users include the principal investigator or responsible person and all other persons working with radiation.

Questions relating to the policies and regulations in this Manual can be discussed by calling Mr. George A. Bodmer (684-7269), or Dr. James B. Lucas (684-7249).

James B. Lucas, M.D.
Chairman, Radiation
Safety Committee

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RADIATION SAFETY MANUAL

ENVIRONMENTAL PROTECTION AGENCY-CINCINNATI RADIOISOTOPE PROGRAM

I. RESPONSIBILITY

A. RADIATION SAFETY COMMITTEE

The Radiation Safety Committee is responsible to the Laboratory Directors for the control of all radionuclides and radiation safety at the EPA-Cincinnati. The Radiation Safety Committee shall designate a responsible Radiation Safety Officer for all operations involving sources of ionizing radiation. Members of the Radiation Safety Committee and the Radiation Safety Staff are previously listed.

Routine uses of radioisotopes are approved by the Chairman, Vice-chairman and Radiation Safety Officer. These applications are then included in the agenda for the next quarterly Radiation Safety Committee meeting for committee discussion and review. All new uses of radioisotopes are brought before the committee and require approval by members present.

B. RADIATION SAFETY OFFICER

The Radiation Safety Officer will be responsible to the Radiation Safety Committee for:

1. Compiling and disseminating information on radiation safety and health physics.
2. Consulting with users of ionizing radiation and giving advice concerning radiological safety.
3. Obtaining all N.R.C. licenses and state and municipal registrations for the EPA-Cincinnati.
4. Reviewing all proposals for isotope usage.
5. Ordering, receiving and recording all radioisotopes and maintaining all records pertinent thereto.
6. Maintaining personnel exposure records and providing personnel and area monitoring, including film badge service.

7. Suspending immediately any operation causing an excessive radiation hazard.
8. Causing routine and special radiation surveys to be performed as deemed necessary in the interest of radiation safety.
9. Approving construction and remodeling of all facilities intended for radioisotope or ionizing radiation use.
10. Supervising disposal of all radioactive wastes.
11. Overall administration of the Radiation Safety Program at the ERC-Cincinnati.
12. Making available up-to-date courses for training necessary for use of radioisotopes and radiation producing devices.
13. Supervising calibration and maintenance of instruments used in the Radiation Safety Program.
14. Shall be notified in case of accidents and shall be responsible for the primary considerations involved in the prevention of spread of contamination.
15. Official notification of NRC and other agencies.

C. DEPUTY RADIATION SAFETY OFFICER(S)

Routine operation of the EPA-Cincinnati Radiation Safety Program under supervision of the Radiation Safety Officer.

D. PRINCIPAL INVESTIGATORS (APPROVED USERS)

1. Compliance with the rules given in the EPA-Cincinnati Radiation Safety Manual.
2. Instruction of personnel under their control in the use of safety devices and procedures.
3. Maintenance of required current records of receipt, use, storage, survey and disposal records.
4. Adequate planning of an experiment or procedure to assure that adequate safety precautions are taken.
5. Communication of pertinent information to the Radiation Safety Officer with respect to changes in operational procedures, new techniques, alterations in the physical plant, or new operations which might lead to increased personal exposures or contamination levels in the laboratory or the environment.

6. Direction of personnel under their control to comply with all recommendations to wear personnel monitoring devices. Conduct routine surveys on areas, to survey their hands and clothing, to submit for biological testing, and other methods as may be required from time to time, which are designed to control and reduce their total exposure.

7. Limiting the use of sources under his control to those over whom he has supervision.

E. INDIVIDUAL USERS AND TECHNICIANS

Each person who has any contact with all sources of ionizing radiation has the responsibility to:

1. Keep his exposure to radiation at the lowest possible value and specifically below the maximum permissible exposure listed in the Radiation Safety Manual.
2. Wear the recommended radiation detectors for personnel, such as film badges and pocket ionization chambers.
3. Survey his hands, shoes, body, and clothing for radioactivity and remove all contamination before leaving work area, where applicable, and as required by approved protocol (EPA-295).
4. Use all appropriate protective measures as protective clothing, respiratory protection, remote pipetting devices, ventilated and shielded glove boxes and hoods, and where applicable and as required by approved protocol.
5. Avoid eating, drinking, or smoking in radioisotope laboratories. Storage of food and drinks in radiation areas is prohibited.
6. Maintain good personal hygiene.
7. Check working areas daily or after each radioisotope procedure.
8. Maintain good housekeeping practices in the laboratory.
9. Label radiation equipment and segregate radiation waste and equipment to avoid contamination.
10. Report immediately to the Radiation Safety Officer the details of any significant spill or other accident involving radioactivity.
11. Conduct decontamination procedures as supervised by the Radiation Safety Officer.

II. REQUIREMENTS FOR USE OF RADIONUCLIDES

A. PERSONNEL

1. Research Investigator - Shall submit a protocol, Form EPA-295 (See Appendix B), giving pertinent information about himself, his proposed project, his assistants, and his laboratory. He shall acknowledge receipt of a Radiation Safety Manual and shall demonstrate knowledge of isotope procedure and safety precautions. He is responsible for assuring adequate training to all of his personnel. He is responsible for all records required by the Radiation Safety Office.
2. Assistants - Shall read the Radiation Safety Manual. They are jointly responsible with the research investigator for their training in radiation safety and isotope procedures and for any violation of radiation safety rules in their laboratory.

B. LABORATORIES

1. Floors - smooth and continuous surfaces are recommended; tiles, and other floor coverings, are acceptable if cracks are filled with wax.
2. Walls, Ceiling and Woodwork - non-porous surfaces, should be washable.
3. Ventilation - labs with more than 10 microcuries of isotopes should have hoods with face velocities of at least 100 feet per minute.
4. Equipment - suitable equipment for the activity, type, and level, shall be available; use of absorbent paper and strippable paint is recommended.
5. Benches - non-porous tops with no sharp corners.
6. Monitoring - appropriate to the isotope(s) used will be required as a routine procedure.

III. PROCUREMENT OF RADIONUCLIDES

Procedure for the procurement of radionuclides is as follows:

- A. Obtain a questionnaire for users of radioactive materials, Form EPA-295 (Appendix B), from the Radiation Safety Office. (A discussion with the Radiation Safety Officer or his Deputy at this time is often helpful.) Follow the directions obtained with the questionnaire in filling out parts A and B as appropriate.

B. Return the questionanaire to the Radiation Safety Office for appraisal. As approved, it will be stamped with the "Radioisotope Approved" stamp and a photocopy returned for file. If it is not approved, the investigator will be contacted by the Radiation Safety Officer or his deputy with suggestions for a revised protocol.

C. Protocols involving all human uses for research shall be approved by the Radiation Safety Committee.

D. When the protocol has been approved, the investigators name is placed on the approved purchaser list for isotopes. When the investigator receives the photocopy of his approved protocol he may purchase the appropriate isotope by:

1. Filling out a standard purchase order requisition. However, the mailing address for the radioactive materials should be to the Radiation Safety Office.
2. Forwarding the requisition to the Radiation Safety Office for the approval stamp. (The Purchasing Department will not honor a request for radioactive material without the approval stamp on the form.) The Radiation Safety Office receives the material for radiation monitoring to insure its safety prior to use by investigator.
3. The investigator or his department is then notified and he or his assistant may sign for the material at the Radiation Safety Office.
4. When he signs for the radionuclide, the person obtaining it will also receive an isotope use record card which is to be maintained as the material is used. This card is then to be returned to the Radiation Safety Office when the container is disposed of or the last of the material is used whichever comes last.

IV. STORAGE OF RADIONUCLIDES

A. LIQUIDS AND SOLIDS

All stored radioactive samples shall be clearly labelled at all times giving isotope(s) chemical form, the activity and the date of activity, and the name of the responsible investigator.

Storage sites for large amounts of radioactive materials should be as remote from occupied areas as practical. Background radiation in unrestricted areas shall be such that individuals continuously in these areas will not receive a dose in excess of 2 millirems in any one hour or 100 millirems in any seven consecutive days. Body exposure in unrestricted areas shall be such that any individual will not receive a dose in excess of 0.5 rems (500 mrem) in any one calendar year.

The storage place should be chosen so as to minimize risk from fire, and should be provided with a suitable means of exit. Storage areas must be well-marked with "CAUTION RADIOACTIVE MATERIALS" signs (See Appendix C). The name, address, and telephone number of the responsible person, the Radiation Safety Officer, and the deputy radiation safety office shall be posted in a conspicuous place near the area.

B. GASES

The storage requirements listed above in A apply as well as the following consideration: Radioactive solutions that emit gases should be labeled and kept in approved hoods which are provided with filters and have adequate ventilation. Only amounts of material necessary for immediate experiments should be stored in the laboratory. For maximum permissible concentration in air, consult the Federal Register, Appendix B, Chapter 1, Part 20, Table I, column 1.

V. RADIATION PROTECTION MEASURES

A. EXTERNAL

The basic protective measures to reduce external radiation are time, distance, and shielding. In every situation these three factors must be considered jointly. While shielding is desirable in reducing the exposure, it must not be overlooked that doing the job in one-half the time is just as effective as doubling the shielding. Working twice as far from a point source is as effective as using four (4) times as much shielding. Continuous use of monitoring equipment is the best method of evaluating the hazard and reducing the exposure. Every user of radionuclides should have on hand adequate survey instruments to keep check on his operations.

B. INTERNAL

The prevention of internal exposure is more exacting and less easily performed than is that of external exposure. The maximum permissible levels of radioactive contamination in the air or on laboratory surfaces is of such a low level that they cannot be detected with ordinary survey instruments. If a low level contamination is suspected (anytime there is a spill), contact the Radiation Safety Office for a survey. The general policy in the use of radioisotopes is to use such equipment and procedures which will most reduce the probability of ingestion of radioisotopes into the body. Outlined below are general rules and procedures for this purpose:

1. Eating, drinking, smoking, and use of cosmetics are not permitted in laboratories or rooms where radioactive materials are used or stored.

2. Solutions shall not be pipetted by mouth.
3. Protective clothing appropriate to conditions shall be worn. A laboratory coat and gloves are the minimum protective clothing to be worn. PROTECTIVE CLOTHING IS NOT TO BE WORN OUTSIDE THE LABORATORY, i.e. offices, counting rooms, etc. NEVER WEAR LABORATORY COATS TO THE CAFETERIA. Monitor clothing before it is returned to laundry.
4. Wash hands thoroughly before leaving the laboratory.
5. If contamination is suspected, all work shall be halted immediately and the Radiation Safety Officer contacted to evaluate the condition and give advice.
6. All injuries shall be monitored to determine possible contamination. (Call Radiation Safety Officer at once.)
7. Special protection is required for wounds so as to prevent the entry of radioactive materials. Waterproof adhesive tape should seal any other bandaging.
8. Everything in the laboratory or room is to be considered contaminated and should be monitored before removing from the laboratory.
9. All persons issued monitoring equipment (film badges, etc.) shall wear the issued equipment at all times when in or near radiation areas. They shall not wear them home.
10. All persons working with radioactive materials shall be aware of radiation safety procedures. The principal investigator is responsible to see that his people have been properly trained and have read the "Radiation Safety Manual".
11. Radioactive material shall be used and stored in a way which prevents unauthorized access to radioactive materials.
12. All containers for radioactive material shall be properly labeled (per 10CFR, part 20).

C. HANDLING PROCEDURES

1. Radioactive materials are to be handled only by persons aware of the hazards of the material.
2. The shipping container shall be opened and treated as though it were contaminated inside until monitored to prove differently.

3. When handling radioactive material (except in the shipping container) personnel shall wear gloves and work on a surface covered with absorbent paper or equivalent material.
4. Remote handling equipment will be used when the external radiation of a container exceeds 38 mr/hr at 1 centimeter (maximum permissible exposure rate to hands and forearms).
5. To reduce the risk of spills to a minimum:
 - a. use double containers
 - b. use protective covering and lids
 - c. use unbreakable containers to store radioisotopes
 - d. use caution in transfers - try a "dry run" without using radioactive materials
 - e. use dry box for dusty materials
 - f. use propipettors - never pipette by mouth
 - g. use absorbent paper or equivalent to cover work surface to contain any possible spill

D. GOOD HOUSEKEEPING HABITS

Much of the job of preventing the spread of contamination is a matter of good housekeeping.

1. Keep the laboratory neat and clean. Keep the work area free of equipment and materials not required for the immediate procedure.
2. Wash hands and arms thoroughly before handling any object which goes to the mouth, nose or eyes. Monitor the hands whenever contamination is suspected and decontaminate immediately.
3. Keep fingernails short and clean. Do not work with radioactive materials if there is a break in the skin below the wrist unless the wound is so protected that radioactive materials cannot gain access to the body. Cover the break with tape (waterproof) and wear a rubber glove.

E. RESTRICTION AND LABELING OF RADIATION AREAS

All radiation areas are to be properly labeled and as such are to be restricted from entrance by unauthorized personnel. The design of the Radiation Symbol is given in the Federal Register, Section 20.203, Chapter 1, Part 20. A sign bearing the radiation caution symbol and the words "Caution High Radiation Area" (See Appendix D) will be posted when the level in such an area is such that a major portion of the body could receive in any one hour a dose in excess of 100 millirem. A sign bearing the radiation caution symbol and the words "Caution Radiation Area" (See Appendix E) will be posted when the level in such an area is such that a major portion of

the body could receive in any one hour a dose in excess of 5 millirem. A sign bearing the radiation caution symbol and the words "Caution Airborne Radioactivity Area" will be posted when any room, enclosure, or operating area in which airborne radioactive materials exist in concentrations in excess of the amounts specified in Title 10, Chapter 1, Code of Federal Regulations, Part 20, Appendix B, Table 1, column 1. A sign bearing the radiation caution symbol and the words "Caution Radioactive Materials" (See Appendix C) will be displayed on each container in which is transported, stored, or used a quantity of any licensed material greater than the quantity of such material specified in Appendix C of the 10 CFR 20, Chapter 1.

Form NRC-3 "Notice to Employees" (See Appendix F) shall be posted in a sufficient number of places in every establishment where employees are engaged in activities licensed by the Commission to permit them to observe a copy on the way to or from their place of employment.

F. MONITORING AND SURVEY

Each person is responsible for monitoring his personal clothing, shoes, and laboratory equipment. Each laboratory and/or special project is responsible for providing appropriate survey devices.

1. Personnel Monitoring

a. Film Badges - Any person who has a probability of being exposed to significant amounts of external radiation should be issued a film badge.

b. Pocket Dosimeters - Personnel working with any source of radiation where an hourly whole body dose of 100 millirems is possible shall wear a pocket chamber.

c. Survey Meters - Every radioisotope laboratory shall have a working survey meter available. This will usually be of the Geiger-Mueller type. This instrument is for the use of personnel in laboratories to check for contamination and is suitable for such routine use of:

(1) Checking laboratory surfaces, glassware, and tools for beta-gamma contamination.

(2) Checking hands, shoes, and clothing.

(3) Measuring the radiation level from low level sources (less than 20 mr/hr).

d. It is difficult to survey laboratory areas where low-energy beta emitters (as ^{14}C , ^3H , etc.) are used. Tissue or filter paper wipes may be made of these areas and the wipes counted in proper instrument (liquid scintillation counter).

2. Laboratory Monitoring and Survey - Periodic monitoring of the radioisotope laboratories will be conducted by the Radiation Safety Officer from time to time. The Radiation Safety Officer shall have a floor plan of each laboratory. During the periodic checkup, the Radiation Safety Officer will record on this floor plan dose rates at various points such as sinks, lab tables, hoods, and handling equipment using the appropriate survey meter. Also recorded on this floor plan will be a wipe test of the most frequently used lab table. This wipe will be made with a piece of moistened filter paper and, depending on the type of source present, counted for either/or all alpha, beta, and gamma radiations. Each sealed source, containing byproduct material with a half-life greater than 30 days shall be tested for leakage and/or contamination. The test shall be performed on the sealed source surface or on the accessible surfaces of the device in which such a source is permanently or semipermanently mounted. The tests will be performed using moistened cotton applicators or filter paper. Wipes will be counted with appropriate instrumentation (e.g. alpha, gas flow, beta-thin window G.M., or liquid scintillation, gamma-crystal scintillation) to determine radioactivity. Records of leak test results will be maintained by the Radiation Safety Officer. These tests will be performed every six months (every three months for alpha emitters) and will be supervised by the Radiation Safety Officer. Servicing, maintenance, and repair of source will be performed by source supplier.

Sampling of air will be performed by the Radiation Safety Officer in various areas in which radioisotopes are being used as required in research protocol, EPA-295. There will be monitoring for tritium concentration in the air near tritium-labeling experimental setups as required in research protocol EPA-295.

All potentially exposed personnel involved in tritium-labeling procedures will be subjected to a regular program of urinary monitoring as follows:

- a. In amounts of 25 mCi to 100 mCi, bioassays will be performed every 6 months.
- b. In routine handling of amounts of 100 mCi to 8 curies bioassays will be submitted weekly.
- c. In amounts greater than 8 curies bioassays will be submitted daily.
- d. When radiochemical procedures involve tritium labeled organics, a single catch sample of urine will be analyzed for tritium every three months when 10 mCi or more are used during this period of time.

When radiochemical procedures involve protein iodination, thyroid counting of personnel involved (as well as two others

from the laboratory as controls) will be performed the day after iodination if 2 mCi or more of iodine is used.

Persons receiving packages containing 1 mCi or more of gamma emitting radioisotopes may, at various times, be required to be counted in Whole Body Counter. New personnel most likely to use these quantities of gamma emitting radioisotopes shall be counted prior to use in order to establish a baseline for monitoring.

3. Animal Room Monitoring - If radioactive isotopes are administered to animals, the rooms in which the animals are housed shall be labeled with a "Caution Radiation Area" sign. A periodic monitoring of the animals will be made by the personnel working in the laboratory. Dose rates are to be measured and recorded at a distance of one foot from the animals, at the initiation of each new experiment.

A chart should be conspicuously posted indicating these dose rates. If the dose rate at one foot is greater than 2.25 mr/hr, contact the Radiation Safety Officer.

G. CALIBRATION OF SURVEY METERS

All survey meters used routinely in the Radiation Safety Program shall be calibrated once every six months. The calibration will be performed by the Radiation Safety Officer or Deputy. Each laboratory may bring its survey instruments to the Radiation Safety Office and request a calibration at any time that malfunction is suspected. Upon completion of the calibration, an instrument calibration record will be posted on the survey meter indicating the date of calibration. The user will be responsible for maintaining the calibration at intervals not exceeding six months.

H. PERMISSIBLE EXPOSURES

The maximum permissible external exposure for personnel occupationally exposed is 100 millirem per week.

The maximum permissible average body burden of radionuclides for persons outside of the controlled area and attributable to the operations within the controlled area shall not exceed one-tenth of that for a radiation worker, i.e., 10 millirem per week.

Persons under 18 years of age shall not be occupationally exposed to ionizing radiation.

Personnel over 18 years of age will be permitted to deliver unopened packages of radioisotopes.

No one without proper training shall be allowed to transport or handle other types of radioactive materials, such as sealed sources, radioactive phantoms and standards.

I. CONTAMINATED EQUIPMENT

Radioactive contamination is defined as the deposition of radioactive material in any place where it is not desired and particularly in any place where presence may be harmful. Contaminated equipment shall not be used again until properly decontaminated (See table in Section VIII-B).

Equipment that may be re-used should be decontaminated. (See section VIII Decontamination Procedures.) Contaminated equipment no longer of any use may be discarded in the dry active waste can. If too large for such disposal, request a survey and disposal information from the Radiation Safety Officer.

J. INSTRUCTIONS FOR VISITORS

All protection measures pertinent to personal safety mentioned above apply to all visitors. No visitors are permitted in any laboratory using a radiation source unless accompanied by a qualified individual familiar with the hazards involved. All visitors shall be issued a personnel monitoring device when they enter an area in which radioactive materials are located in such amounts that they constitute a potential personnel hazard or increase the possibility for spread of contamination. Accumulated doses shall be recorded for the visitor along with the individuals name, age, and address; and this information sent in a written memorandum to the Radiation Safety Officer to be kept on file.

VI. DISPOSAL

Records of the amounts, in microcuries, of all radioisotope disposals must be maintained.

Radionuclides at the EPA-Cincinnati are disposed of in the following manner:

A. DECAY

If the radionuclide is short-lived, it may be stored until the activity has decayed. When the activity is below the maximum permissible level given in Appendix B of the Federal Register, Chapter 1, part 20, table 1, Column 2, the material may be discharged into the sewer. If the half-life is greater than 30 days, this method becomes impractical.

B. LIQUID DISPOSAL

1. Sewer Disposal - If the radionuclide is readily soluble or

dispersible in water, it may be flushed down the drain providing the activity is below maximum permissible levels. An assay must be made to determine the exact amounts of activity present and the dilution necessary. See Table 1 for maximum permissible discharge of material into a sanitary sewerage system. Only sinks that are designated as disposal sinks for a particular area shall be used.

2. Non-Sewer Disposal - If a liquid waste cannot be disposed of by the sewer method, it may be precipitated or evaporated and treated as a solid waste. Care should be taken in handling dry material (i.e. dust) to prevent air contamination; or, it can be stored in a properly identified liquid waste container to be disposed of by the Radiation Safety Officer.

A Radioactive Waste Container Log Form must be kept for all radioactive disposal drums. (See Appendix G.)

C. INCINERATION

Combustible material containing radionuclides may be incinerated in the Animal Wing incinerator only if the concentrations in effluent to unrestricted areas are not in excess of the limits specified in Appendix B of the Federal Register, Chapter 1, Part 20, Table II. Principle Investigator shall confer with RSO to determine maximum activity of radionuclide which may be incinerated at any time.

All animals, excreta, and other material containing radioisotopes that are to be incinerated shall be contained in a plastic bag and clearly labeled with departmental location, personnel in charge, the isotope contained therein, the amount in microcuries of the isotope and the date when this amount is present. A record of the amounts, in microcuries of all radioisotopes incinerated shall be maintained. The Incineration Record Form EPA-300 is shown in Appendix H. This record is kept by personnel operating the incinerator.

D. SOLID WASTES

If the radionuclide is water soluble, it may be flushed down the drain providing the activity is below maximum permissible concentration. (See Table 1 on following page.) An assay shall be made to determine the exact amounts of activity present and the dilution necessary. See Table 1 on following page for maximum permissible discharge of material into a sanitary sewerage system. All other solid wastes should be stored in steel waste cans or drums to be shipped to a disposal agency. The laboratories which produce solid wastes should have a radioactive waste can (arrangements may be made with Radiation Safety Office for procurement and disposal of can). This can shall be lined with a disposable plastic bag.

Table 1

MAXIMUM PERMISSIBLE CONCENTRATIONS OF RADIOISOTOPES
(Water Soluble and Only in Authorized Disposal Sinks)

<u>Isotope</u>	<u>uCi/ml Water</u>
Br-82	8×10^{-3}
Cd-109	5×10^{-3}
Ca-45	3×10^{-4}
C-14	2×10^{-2}
Ce-141	3×10^{-3}
Cl-36	2×10^{-3}
Cr-51	5×10^{-2}
Co-57	2×10^{-2}
Co-60	1×10^{-3}
H-3	1×10^{-1}
I-125	4×10^{-5}
I-131	6×10^{-5}
Fe-55	2×10^{-2}
Fe-59	2×10^{-3}
Mn-54	4×10^{-3}
Hg-203	5×10^{-4}
Ni-63	8×10^{-4}
P-32	5×10^{-4}
K-42	9×10^{-3}
Na-22	1×10^{-3}
Sr-85	3×10^{-3}
S-35	2×10^{-3}

Others Available from Radiation Safety Office Upon Request.

Table 1,

VII. EMERGENCY PROCEDURES

Emergencies resulting from accidents in laboratories working with radioactive materials will range from simple spills of small amounts of radioactive materials, where no serious contamination problem results, to major disasters occurring from explosions, fires, or natural phenomena. Correspondingly, the hazards resulting from such accidents will cover the range of situations from no hazard whatsoever to very serious situations involving extreme radiation hazards and bodily injury or both. In view of the complicating factors that may arise during such emergencies, simple rules of procedure cannot be set down covering all situations of radiation danger. However, in any emergency primary concern must always be the protection of laboratory personnel from radiation hazards. Second should be the confinement of the contamination to the local area of the accident, if this is possible.

A. WHOM TO CALL AND WHEN

In the event of an emergency or suspected emergency, e.g. spills, bodily injury, fire, etc., the Radiation Safety Officer and Chairman of the Radiation Safety Committee shall be notified immediately. (See Cover 2.) In addition, each particular lab should have posted the location of the nearest fire alarm or telephone number of the fire department and the Radiation Safety Office personnel.

B. LOSS OF SOURCES

In the event of a loss of any radioactive source, notify all personnel in the lab area or building, if necessary. Evacuate the area if necessary and take, where applicable, the appropriate steps listed below.

Contact the Radiation Safety Officer at once and request consultation and survey.

C. MINOR SPILLS INVOLVING NO RADIATION HAZARD TO PERSONNEL

1. Notify all other persons in the room at once and retain them nearby.
2. Turn off air conditioners and seal area.
3. Notify the Radiation Safety Officer as soon as possible.
4. Permit only the minimum number of persons necessary to deal with the spill into the area.

5. Confine the spill immediately.
Liquid Spills: Don protective gloves.
Drop absorbent paper on spill.
Dry Spills: Don protective gloves and scoop up.
Dampen thoroughly, taking care not to spread the contamination.
6. Decontaminate (See Section VIII-B)
7. Monitor all persons involved in the spill and cleaning.
8. Permit no persons to resume work in the area until a survey is made, and approval of the Radiation Safety Officer is secured.
9. Prepare a complete history of the accident and subsequent activity related thereto for the laboratory records with a copy to the Radiation Safety Officer.

D. MAJOR SPILLS INVOLVING RADIATION HAZARD TO PERSONNEL

1. Notify all persons not involved in the spill to vacate the room at once.
2. If the spill is liquid, and the hands are protected, right the container.
3. If the spill is on the skin, flush thoroughly.
4. If the spill is on clothing, discard outer or protective clothing at once.
5. Switch off all fans and air conditioners.
6. Vacate the room.
7. Notify the Radiation Safety Officer as soon as possible.
8. Take immediate steps to decontaminate personnel involved as necessary.
9. Decontaminate the area under supervision of Radiation Safety Office. (Personnel involved in decontamination must be adequately protected.)
10. Monitor all persons involved in the spill and cleaning to determine adequacy of decontamination.
11. Permit no person to resume work in the area until a survey is made and approval of the Radiation Safety Office is secured.

12. Prepare a complete history of the accident and subsequent activity related thereto for the Radiation Safety Officer's records.

E. ACCIDENTS INVOLVING RADIOACTIVE DUSTS, MISTS, FUMES, ORGANIC VAPORS AND GASES

1. Notify all other persons to vacate the room immediately.
2. Hold breath and close escape valves, switch off air circulating devices, etc., if time permits.
3. Vacate the room.
4. Notify the Radiation Safety Officer at once,
5. Ascertain that all doors giving access to the room are closed and post conspicuous warnings or guards to prevent accidental opening of doors.
6. Report at once all known or suspected inhalations of radioactive materials.
7. Evaluate the hazard and the necessary safety devices for safe re-entry.
8. Determine the cause of contamination and rectify the condition.
9. Decontaminate the area under supervision of Radiation Safety Office.
10. Perform air survey of the area before permitting work to resume.
11. Monitor all persons suspected of contamination.
12. Prepare a complete history of the accident and subsequent activity related thereto for the laboratory records with a copy for the Radiation Safety Officer.

F. INJURIES TO PERSONNEL INVOLVING RADIATION HAZARD

1. Wash minor wounds immediately, under running water, while spreading the edges of the wound.
2. Report all radiation accidents to personnel (wounds, over-exposure, ingestion, inhalation) to the Radiation Safety Officer as soon as possible.
3. Call a physician, qualified to treat radiation injuries, at once.

4. Permit no person involved in a radiation injury to return to work without the approval of the Radiation Safety Officer and the attending physician.

5. Prepare a complete history of the accident and subsequent activity related thereto for the Radiation Safety Officer's records.

G. FIRES OR OTHER MAJOR EMERGENCIES

1. Notify all other persons in the room and building at once.

2. Attempt to put out fires if radiation hazard is not immediately present.

3. Notify the Radiation Safety Officer.

4. Notify the fire department and other local safety personnel.

5. Govern fire-fighting or other emergency activities by the restrictions of the Radiation Safety Office.

6. Following the emergency, monitor the area and determine the protective devices necessary for safe decontamination.

7. Decontaminate under supervision of Radiation Safety Office.

8. Permit no person to resume work without approval of Radiation Safety Officer.

9. Monitor all persons involved in combating the emergency.

10. Prepare a complete history of the emergency and subsequent activity related thereto for the Radiation Safety Officer's records.

VIII. DECONTAMINATION PROCEDURES

A. GENERAL CONSIDERATIONS

1. Prevent Spread of Contamination - The RSO should be called for assistance as soon as possible whenever a spill occurs. The first consideration after personnel safety is to decontaminate. Many factors must be considered, including tracking by persons, movement by air currents (hoods, fans, etc.), water, dusting, mopping, and other physical actions. To confine it, decontaminate the spill from the outside toward the center.

2. Make a Plan - Successful decontamination calls for planned action. A spur of the moment action or attempt at decontamination can cause more harm than good. Perhaps the best thing to do after a spill is to go sit in front of the laboratory door and make a

thorough plan of the steps to be taken in the decontamination procedure.

3. Monitoring - Make full use of instruments and available assistance. Each step of the decontamination should be monitored. One person should be kept clean to operate the instruments and do other monitoring. When the instruments become contaminated, any progress is hopeless. Protective clothing, footwear, gloves, and assault masks should be used as needed.

4. Records - Complete records should be made of each action. Copies should be sent to the RSO. In most cases the RSO will be involved so a joint report can be filed.

5. Waste Disposal - Provisions must be made for disposal of cleaning solutions and contaminated articles. In some instances, it may be judged better to dispose of a contaminated article than to attempt to decontaminate it.

B. SPECIFIC PROCEDURES

Specific procedures are outlined in Table 2. Where possible the preferred decontaminating agent is listed first.

IX. RADIATION-PRODUCING MACHINES

All radiation producing machines are under the control of the Radiation Safety Office and shall be registered with the office. Periodic surveys of all Radiation Producing Machines and areas in which these machines are located will be conducted by the Radiation Safety Officer. This should in no way detract from the recommendations listed below for the use of radiation-producing machines

A. GENERAL CONSIDERATIONS

1. Radiation-producing machines shall be operated only by qualified personnel.
2. All radiation-producing machines shall be surveyed prior to routine use and at one-year intervals. A beta-gamma survey instrument is recommended. A pocket chamber or film badge shall be worn.
3. Radiation warning signs shall be placed so as to prevent personnel from entering the radiation area. The signs should indicate clearly the type of radiation hazard present. Signs may be removed when there is no longer any need for them. In certain instances other precautions, such as locking the entrances to the room and interlocks, may be advised.
4. The operator shall not expose himself to the direct beam of a radiation-producing or x-ray machine and shall not stand within 4

(four) feet of the tube or irradiated target while the machine is in operation unless adequately shielded.

5. Make allowances for the range of the radiation. For example, when the beam is directed across the room the radiation will extend into adjoining rooms. Make use of protective barriers, lead aprons, and gloves.

6. Observe any restrictions or recommendations on the use of the machines made by the Radiation Safety Officer.

7. All rules of NCRP Report 33, "Medical X-ray and Gamma-ray Protection for Energies up to 10 MeV - Equipment Design and Use", apply. Copies are available from the Radiation Safety Officer.

X. SEALED SOURCES

All sealed sources are under the control of the Radiation Safety Office.

A. GENERAL

The Radiation Safety Officer shall be notified of all sealed sources brought into the EPA-Cincinnati. Information shall cover the following:

1. Chemical and physical form of the radioactive source and its source container.
2. Permanent location
3. Method of accountability
4. Method of testing
5. Places of use.

B. ALPHA-EMITTING SOURCES (SPECIAL REQUIREMENTS)

1. The Chairman of the Radiation Safety Committee and the Radiation Safety Officer are to be notified concerning all sources of that type in the EPA-Cincinnati when they are brought into or removed from the EPA-Cincinnati.
2. Source foils shall be inspected initially and at least yearly for defects. If any defects are found, the foil shall be disposed of by the RSO.
3. The source holders are to be wiped and monitored for alpha activity on an in-and-out basis during each use and records kept in the book. All sources are to be wiped on a quarterly basis.

4. A log of sources is to be kept.
5. All radioactive sources and radioactive materials of this type are to be stored only in a fire-resistant locked metal container.
6. All sources are to be taken out in a fume hood and an additional individual with an alpha survey meter is to be present at the site of source removal to assist with monitoring.
7. All individuals working with alpha emitters are to read the appropriate procedures of the EPA-Cincinnati Radiation Safety Manual.
8. All individual users must read and follow the operational procedures for the use of the sources.

C. RADIUM STORAGE AREAS

Periodic surveys of all areas where radium is stored will be made by the Radiation Safety Officer. Radium location will be kept by attending personnel and specific location of all radium sources conspicuously posted. Wipe tests will be made of all radium storage containers (Radium Safe) every 6 (six) months by the Radiation Safety Officer. Wipe tests of the individual radium sources will be made when container wipes indicate higher than normally observed values. Records will be kept by the Radiation Safety Officer.

Table 2.

DECONTAMINATION PROCEDURES

Contaminated Area	Decontaminating Agent	Remarks	Maximum Permissible Levels of Contamination
Skin & Hands	Mild soap & water	Wash 2-3 min. and monitor. Do not wash over 3-4 min.	<u>Alpha</u> - 150 dis/min/100 cm ² This is approx. 1/2 the inhalation level in terms of total dis/min/day. This assumes not more than 1/5 of this material will be inhaled. Additional possible exposure by ingestion is also considered.
	If necessary, follow by soft brush, heavy lather, & tepid water.	Use light pressure with heavy lather. Wash for 2 min., 3 times. Rinse & monitor. Use care not to scratch or erode skin. Apply lanolin or hand cream to prevent chapping.	
	<u>Other Procedures</u>		<u>Beta-Gamma</u>
	A mixture of 50% Tide and 50% corn meal.	Make into a paste. Use with additional water with a mild scrubbing action. Use care not to scratch or erode the skin.	Average less than 0.3 mr/hr for each hand surface or 100 cm ² of skin surface, using Geiger-Mueller instrument calibrated with Ra ²²⁶ .
	A 5% water solution of a mixture of 30% Tide, 65% Calgon, & 5% Carbose (Carboxymethyl Cellulose)	Use with water. Rub for a minute & rinse.	
	A preparation of 8% Carbose, 3% Tide, 1% Versene, & 88% water homogenized into a cream. lanolin.	Use without any additional water. Rub for 1 min. and wipe off. Follow with	

Table 2. continued
DECONTAMINATION PROCEDURES

Contaminated Area	Decontaminating Agent	Remarks	Maximum Permissible Levels of Contamination
Skin & Hands (continued)	<u>Chemical Procedures</u>	(As a last resort.)	
	Titanium dioxide paste. Prepare paste by mixing precipitated titanium with a small amount of lanolin.	Work the paste into affected area for 2 min. Rinse and wash with soap, brush, and warm water. Monitor.	
	Mix equal volumes of a saturated solution of potassium permanganate and 0.2 N sulfuric acid. Continue with the next step also. (Saturated solution $KMnO_4$ is 6.4 gms per 100 ml of water.)	Pour over wet hands, rubbing the surface & using hand brush for not more than 2 min. (Note: will remove a layer of skin if in contact with the skin for more than 2 min.) Rinse with water.	
	Apply a freshly prepared 5% solution of sodium acid sulfite ($NaHSO_3$).	Apply in the same manner as above. Apply for not more than 2 minutes. The above procedure may be repeated. Apply lanolin or hand cream when completed.	

Table 2. continued
DECONTAMINATION PROCEDURES

Contaminated Area	Decontaminating Agent	Remarks	Maximum Permissible Levels of Contamination
Wounds (cuts & breaks in skin)	Running Tap Water Report to Medical Officer & Radiation Safety Officer as soon as possible	Wash wound with large large volumes of running water immediately (within 15 sec.) Spread the edges of wound to permit flushing action by water.	Keep wound contamination as low as possible. No MPL can be set.
Ingestion by Swallowing	Immediately induce vomiting. Drink large quantities of liquids to dilute the activity.	Urine and fecal analysis will be necessary to determine amount of radionuclides in the body.	
Clothing	Wash - if levels permit.	Use standard laundering procedures. 3% versene or citric acid may be added to wash water. Wash water must be below the MPL for sewer disposal.	<u>Alpha</u> - 150 dis/min/100 cm ² <u>Beta-Gamma</u> - No area to average more than 0.1 mr/hr. GM meter Ra ²²⁶ calibrated. (If clothing is worn 100 hr/wk, this will give 1/10 of maximum external dose.
See Rubber & Leather under specific materials.	Store Disposal	To allow for decay if contamination is short-lived. Treat as solid waste if necessary.	

Table 2. continued
DECONTAMINATION PROCEDURES

Contaminated Area	Decontaminating Agent	Remarks	Maximum Permissible Levels of Contamination	
Glassware	Soap or detergent and water	Monitor wash water and plan disposal of it.	The maximum permissible levels for glassware that is handled with the bare hands is the same as for the hands and skin.	
	Isoclean	Soak 24-48 hours.		
	Chromic acid cleaning solution or conc. nitric acid.	Monitor wash water and plan disposal of it.		
	<u>Suggested Agents</u>			<u>Elements Removed</u>
	Oxalic acid 5% (caution-poison)	<u>Zr</u> <u>Nb</u> , <u>Hf</u> ,		
	Versene (BDTA) 5%, conc. NH ₄ OH 3%.	Alkaline Earth Metals: <u>Be</u> , <u>Mg</u> , <u>Ca</u> , <u>Sr</u> , <u>Ba</u> , <u>Ra</u> , <u>P</u> as <u>PO</u> ₄ .		
	HCl 10% by volume	Alkali Metals, <u>Na</u> , <u>K</u> , <u>Rb</u> , <u>Cs</u> , and strongly absorbed metals like <u>Po</u> .		
	To make, dissolve IN ORDER:	Trivalent metals, <u>Al</u> , <u>Sc</u> , <u>Y</u> , <u>La</u> , <u>Ce</u> , <u>Pr</u> , <u>Nd</u> , <u>Pm</u> , <u>Sa</u> , <u>Eu</u> .		
	1) Versene (EDTA) 5%	Rare Earths, <u>Ac</u> , <u>Ga</u> , <u>In</u> , <u>Ti</u> , <u>B</u> .		
	2) Conc. NH ₄ OH, 3% by volume	Transition metals, <u>Cu</u> , <u>Zn</u> , <u>Fe</u> , <u>Co</u> , <u>Ni</u> , <u>Cd</u> , <u>Sn</u> , <u>Hg</u> , <u>Pd</u> , <u>Th</u> , <u>U</u> , <u>Ag</u> .		
3) Glacial acetic acid 5% by volume.	(Always consider the radioactivity of the cleaning solution when disposing of it.)			

Table 2. continued

DECONTAMINATION PROCEDURES

Contaminated Area	Decontaminating Agent	Remarks	Maximum Permissible Levels of Contamination
Laboratory Tools	Detergents & water, steam cleaning	Use mechanical scrubbing action.	The maximum permissible levels for tools that are handled with the hands is the same as for the hands and skin.
	Isoclean	Soak	
Metal Tools	Dilute nitric acid, 10% solution of sodium citrate or ammonium bifluoride.	As a last resort, use HCl on stainless steel.	
	Metal polish, sand-blasting, other abrasives.	Such as brass polish on brass. Use caution as these procedures may spread contamination.	
	Isoclean	Soak	
Plastic Tools	Ammonium citrates, dilute acids, organic solvents.	Solvents may attack the plastic	
	Isoclean	Soak	
Glass Tools	Same as above section on Glassware.		
Walls, Floors, Benches	Detergents and water with mechanical action.	This should be the first method of decontamination tried.	NOTE: Water from high pressure sources or steam cleaning may spread contamination.
	Vacuum cleaning	The exhaust of the cleaner must be filtered to prevent escape of contamination	

Table 2. continued
DECONTAMINATION PROCEDURES

Contaminated Area	Decontaminating Agent	Remarks	Maximum Permissible Levels of Contamination
<u>Specific Materials</u>			
Rubber	Washing or dilute HNO ₃ .	(Short-lived contamination may be covered up to await decay.	
Glass Plastic	See the above section.		
Leather	Very difficult to decontaminate.		
Linoleum	CCl ₄ , kerosene, Ammonium citrate, dilute mineral acids.		
Ceramic Tile	Mineral acids, Ammonium citrate, trisodium phosphate	Scrub hot 10% solution into surface and flush thoroughly with hot water.	
Paint	CCl ₄ , 10% HCl acid	Usually best to remove the paint and repaint.	
Brick and Concrete	32% HCl acid	If this is not successful, concrete must be removed.	
Wood	Hot citric acid, remove the wood with a plane or floor chippers and grinders.		
Traps & Drains	1) Flush with water 2) Scour with rust remover. 3) Soak in solution of citric acid. 4) Flush again	<u>Follow all 4 steps.</u>	

XI. GENERAL REFERENCES

Radiation Protection in Educational Institutions (1966), NCRP Report No. 32.

Radiation Protection in Veterinary Medicine (1970), NCRP Report No. 36.

Basic Radiation Protection Criteria (1971), NCRP Report No. 39.

Protection Against Radiation from Brachytherapy Sources (1972), NCRP Report No. 40.

Tritium Measurement Techniques (1976), NCRP Report No. 47.

Radiation Protection for Medical and Allied Health Personnel (1976), NCRP Report No. 48.

Report of Committee III on Protection Against X-Rays up to Energies of 3 MeV and Beta-and Gamma-Rays from Sealed Sources (1960), ICRP Publication 3.

Report of Committee V on the Handling and Disposal of Radioactive Materials in Hospitals and Medical Research Establishments (1964), ICRP Publication 5.

Principles of Environmental Monitoring related to the Handling of Radioactive Materials, ICRP Publication 7.

Recommendations of the International Commission on Radiological Protection (Adopted September 17, 1965), ICRP Publications 9.

Report of Committee IV on Evaluation of Radiation Doses to Body Tissues from Internal Contamination due to Occupational Exposure, ICRP Publication 10.

The Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes, ICRP Publication 10A.

General Principles of Monitoring for Radiation Protection of Workers, ICRP Publications 12.

Radiation Protection in Schools for Pupils up to the Age of 18 Years, ICRP Publication 13.

Protection against Ionizing Radiation from External Sources, ICRP Publication 15.

Title 10, Chap. 1, U.S. Nuclear Regulatory Commission, Rules and Regulations Part 19 Notices, Instructions, and Reports to Workers; Inspections. Part 20 Standards for Protection against Radiation.

XII. UNITS AND DEFINITIONS

Shall - denotes that the ensuing recommendation is necessary or essential to meet the currently accepted standards of protection.

Should - indicates recommendations that are to be applied, where possible, in the interest of minimizing radiation exposure.

Nuclide - any individual nuclear species, such as C^{14} , P^{32} , I^{131} , etc., irrespective of whether or not the nuclide has other isotopes. The term isotope is frequently misused for nuclide, but the strict meaning of the former as originally defined by Soddy (1914) is of the same place: i.e., in the same position in the periodic table. Thus one may say that the nuclide phosphorus-32 is an isotope of phosphorus, or even more specifically of, say, phosphorus-33. A radioactive nuclide is often referred to as a radionuclide.

Curie - the quantity of any radioactive material in which the number of disintegrations is 3.7×10^{10} per sec.

Attenuation - decrease in exposure rate of radiation caused by passage through material.

Controlled Area - a defined area in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of an individual in charge of radiation protection. (This implies that a controlled area is one that requires control of access, occupancy, and working conditions for radiation protection purposes.)

Exposure Dose - the exposure dose of X- or gamma radiation at a certain place is a measure of the radiation that is based upon its ability to produce ionization. The unit of exposure dose is the roentgen.

Roentgen - an exposure dose of X- or gamma radiation such that the associated corpuscular emission per .001293 gm of air produces, in air, ions carrying 1 electrostatic unit of quantity of electricity of either sign.

Absorbed Dose - energy imparted to matter by ionizing particles per unit mass of irradiated material at the place of interest. The unit of absorbed dose is the rad.

Rad - a unit of absorbed dose. 1 rad is 100 ergs/gm.

RBE Dose - RBE (relative biological effectiveness) dose is numerically equal to the product of the dose in rads and an agreed conventional value of the RBE with respect to a particular form of radiation effect.

Rem - the unit of RBE dose.

Film Badge - a pack of appropriate photographic film and filters used to determine radiation exposure.

Pocket Chamber - a small condenser ionization chamber used for determining radiation exposure. An auxiliary charging and reading device is usually necessary.

Maximum Permissible Dose - (MPD) The maximum RBE dose that the body of a person or specific parts thereof shall be permitted to receive in a stated period of time.

Appendix A

CERTIFICATION FOR USE OF RADIATION

Original must be filed with the Radiation Safety Committee. A copy will be returned to the individual completing this form. This form must be completed before beginning work with radiation.

NAME _____ DATE OF BIRTH _____ SEX M F

HOME ADDRESS _____ HOME PHONE _____

TITLE _____

LOCATION OF LABORATORY _____ PHONE _____

LOCATION OF OFFICE _____ PHONE _____

SUPERVISOR _____

I wish to enroll in the next radiation safety class

I certify that I have received instruction in the safe use of radiation, that I have read and understand the Environmental Protection Agency Radiation Safety Manual and the regulations of the U.S. Nuclear Regulatory Commission.

DATE _____

SIGNED _____

Applicant certified by: Completing Course on _____
date
By previous training

Per _____
(Radiation Safety Officer) _____ (date)

FOR INDIVIDUALS HAVING PREVIOUS RADIATION EXPERIENCE:

APPLICANT HAS HAD ACEQUATE TRAINING AND EXPERIENCE AT _____

from _____ to _____ under the supervision of _____

(Name and Title)

(NOTE:) You are required to read and understand the Environmental Protection Agency Radiation Safety Manual and regulations of the NRC.

The original of this form is to be sent to the Safety/Security Office, Attn: Radiation Safety Committee, before beginning work with radiation.

EPA-294 (Cin)
(2-77)

Appendix B

QUESTIONNAIRE FOR USERS OF RADIOISOTOPES

THIS FORM MUST BE COMPLETED AND APPROVED PRIOR TO PURCHASING RADIOISOTOPES FOR USE IN THE EXPERIMENT. THE RADIATION SAFETY OFFICE MUST BE NOTIFIED PRIOR TO ANY CHANGE IN TECHNIQUE, ISOTOPE OR PERSONNEL INVOLVED IN THIS EXPERIMENT.

(Please Type)

PART A

Date: _____

Department: _____

Phone No: _____ Responsible Investigator: _____

Previous experience with Radioisotopes of Responsible Investigator: (Include dates, location and radioisotopes used)

Experience prior to obtaining EPA approval (only for initial application)

Approved by Environmental Research Center Radiation Safety Committee as of _____ date.
Previous experience of other personnel (give names) involved in this experiment:

Have personnel had previous occupational radiation history before working at the Environmental Research Center?

Name _____ Employer _____ Address _____ Dates _____

Name _____ Employer _____ Address _____ Dates _____

Name _____ Employer _____ Address _____ Dates _____

Personnel who wish to enroll in the next radiation safety course (mandatory for those with no previous experience) _____

Do you have a copy of the "Environmental Protection Agency Radiation Safety Manual"? _____

Have you read the Safety Manual? _____

Have the other personnel read the Safety Manual? _____

Note: It is a requirement both of the Environmental Protection Agency and of our NRC broad license that each worker with radiation has actually read the Environmental Protection Agency Safety Manual. Failure of you and your personnel to comply may result in termination of the privilege of using radioisotopes.

Appendix B continued

PART B

EXPERIMENTAL PLAN

Title of Experiment _____

Starting Date _____ Expected Date of Completion _____

Location (Bldg. and Room Number) _____

TYPE OF MATERIAL:

Physical and Chemical form _____

Isotope _____ Total Activity per Purchase _____

RADIATION SURVEY PROCEDURE: _____

_____ Frequency of Survey _____

Do you have film badges? _____ Do you have a survey meter? _____ Manufacturer _____

Model _____ Serial No. _____ Bldg. _____ Room _____

Solid Waste Disposal Procedure: _____

Liquid Waste Disposal Procedure: _____

Do you have an authorized disposal sink? _____ Sink number _____ Rm., Loc. _____

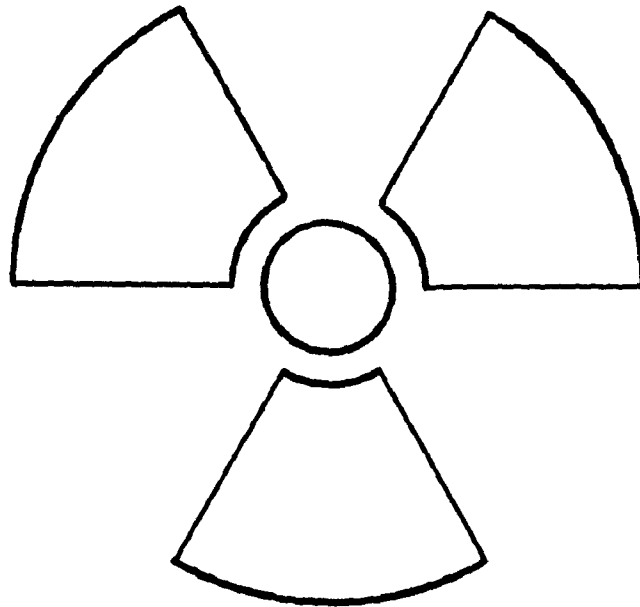
Have you discussed your project, including waste disposal with personnel from the Radiation Safety Office? If so, With Whom? _____ When _____

Have radioactive materials been used in the proposed location (s) (room, bench, and/or apparatus) previously? _____

PROTOCOL

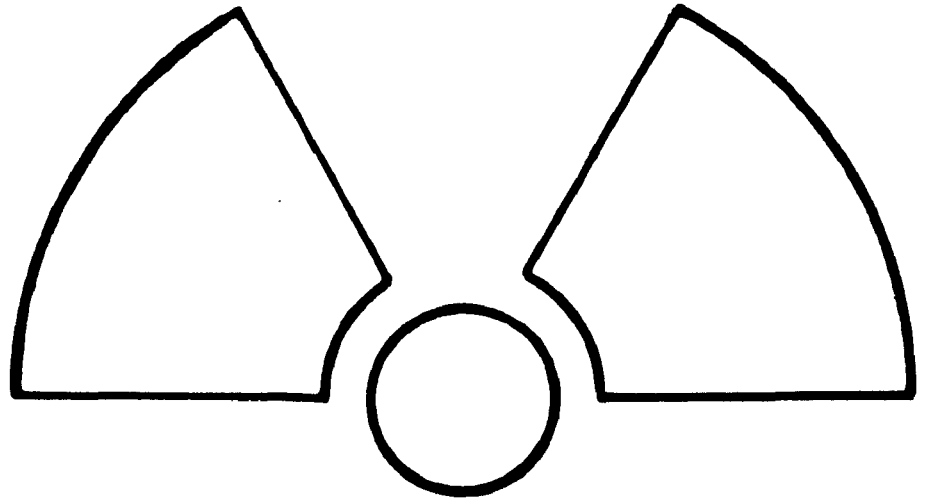
Please give a brief description of your project (experiment). Theory of experimental work should be omitted. A detailed step by step outline of the physical handling of the isotope is to be given. Include any isotope dilution technique, how the isotope is used (I.V., I.P., etc., in vivo injections, culture media for cell growth, etc.), the activity used per experiment and the safety procedures (gloves, absorbent paper, etc.) to be used. (Please use space below).

CAUTION

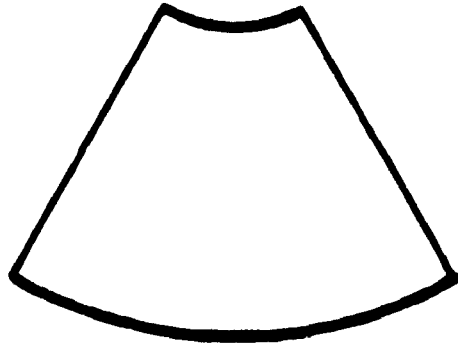


**RADIOACTIVE
MATERIALS**

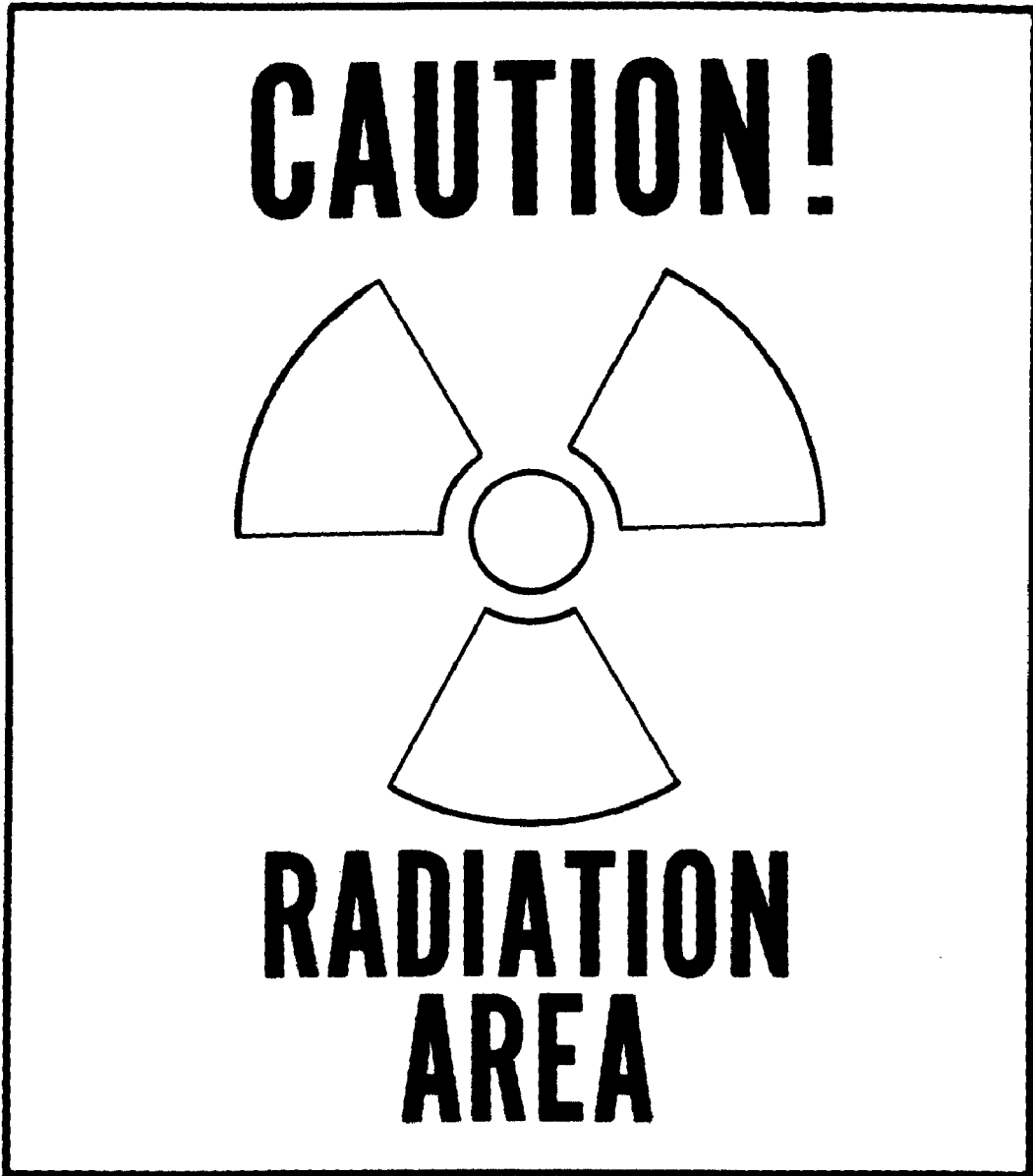
CAUTION



HIGH



RADIATION AREA





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

NOTICE TO EMPLOYEES

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

In Part 20 of its Rules and Regulations, the Nuclear Regulatory Commission has established standards for your protection against radiation hazards from radioactive material under license issued by the Nuclear Regulatory Commission. In Part 19 of its Rules and Regulations, the Nuclear Regulatory Commission has established certain provisions for the options of workers engaged in NRC-licensed activities.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to —

1. Apply these NRC regulations and the conditions of his NRC license to all work under the license.
2. Post or otherwise make available to you a copy of the NRC regulations, licenses, and operating procedures which apply to work you are engaged in, and explain their provisions to you.
3. Post Notices of Violation involving radiological working conditions, proposed imposition of civil penalties and orders.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the NRC regulations, and the operating procedures which apply to the work you are engaged in. You should observe their provisions for your own protection and protection of your co-workers.

WHAT IS COVERED BY THESE NRC REGULATIONS

1. Limits on exposure to radiation and radioactive material in restricted and unrestricted areas;
2. Measures to be taken after accidental exposure;
3. Personnel monitoring, surveys and equipment;
4. Caution signs, labels, and safety interlock equipment;
5. Exposure records and reports;
6. Options for workers regarding NRC inspections; and
7. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The NRC regulations require that your employer give you a written report if you receive an

POSTING REQUIREMENTS

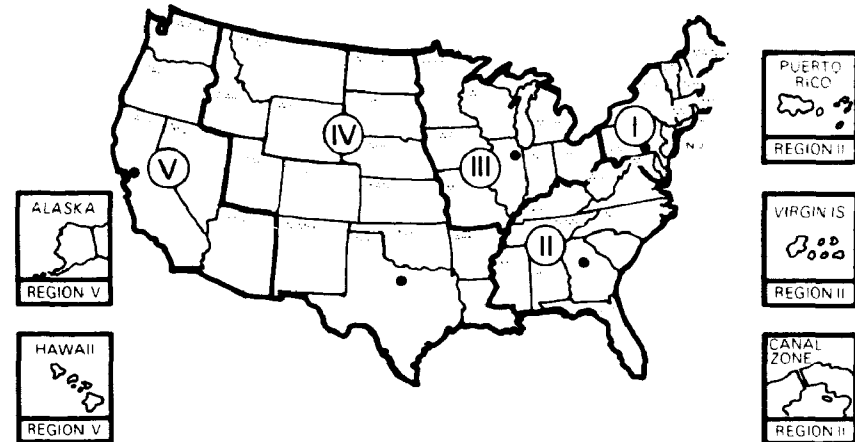
Copies of this notice must be posted in a sufficient number of places in every establishment where activities licensed by the NRC are conducted, to permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.

exposure in excess of any applicable limit as set forth in the regulations or in the license. The basic limits for exposure to employees are set forth in Sections 20.101, 20.103, and 20.104 of the Part 20 regulations. These Sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air.

2. If you work where personnel monitoring is required pursuant to Section 20.202:
 - (a) your employer must give you a written report of your radiation exposures upon the termination of your employment, if you request it, and
 - (b) your employer must advise you annually of your exposure to radiation, if you request it.

INSPECTIONS

All activities under the license are subject to inspection by representatives of the NRC. In addition, any worker or representative of workers who believes that there is a violation of the Atomic Energy Act of 1954, the regulations issued thereunder, or the terms of the employer's license with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to the appropriate United States Nuclear Regulatory Commission Inspection and Enforcement Regional Office (shown on map at right). The request must set forth the specific grounds for the notice, and must be signed by the worker or the representative of the workers. During inspections, NRC inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which he believes contributed to or caused any violation as described above.



Appendix F

UNITED STATES NUCLEAR REGULATORY COMMISSION

Regional Offices

REGION	ADDRESS	TELEPHONE	
		DAYTIME	NIGHTS AND HOLIDAYS
I	Region I, Office of Inspection and Enforcement, USNRC 631 Park Avenue King of Prussia, Pennsylvania 19406	215 337-1150	215 337-1150
II	Region II, Office of Inspection and Enforcement, USNRC 230 Peachtree Street, N.W., Suite 815 Atlanta, Georgia 30303	404 526-4503	404 526-4503
III	Region III, Office of Inspection and Enforcement, USNRC 799 Roosevelt Road Glen Ellyn, Illinois 60137	312 858-2660	312 858-2660
IV	Region IV, Office of Inspection and Enforcement, USNRC 611 Ryan Plaza Drive, Suite 1000 Arlington, Texas 76012	817 334-2841	817 334-2841
V	Region V, Office of Inspection and Enforcement, USNRC 1990 N. California Boulevard, Suite 202, Walnut Creek Plaza Walnut Creek, California 94596	415 486-3141	415 486-3141

Appendix G

RADIATION SAFETY

RADIOACTIVE WASTE CONTAINER LOG

CONTAINER NO. _____ TYPE CONTAINER _____
(Description and Size)

LOCATION _____
(Room and/or Area) (Building)

DATE	ISOTOPE	TYPE OF WASTE	AMOUNT	RADIATION LEVEL	DISPOSED BY

I certify there is enough absorbent material contained in this drum to absorb twice the amount liquid present.

NAME _____ DATE _____

EPA-296 (Cin)
(2-77)

INCINERATION RECORD FORM

MONTH _____ 19 _____

LOCATION _____

Day	ISO	AMT	SIG	DAY	ISO	AMOUNT	SIG	DAY	ISO	AMOUNT	SIG	DAY	ISO	AMOUNT	SIG
1				9				17				25			
2				10				18				26			
3				11				19				27			
4				12				20				28			
5				13				21				29			
6				14				22				30			
7				15				23				31			
8				16				24							

Appendix H

ISO-Isotope
 AMT-Amount incinerated
 SIG-Signature of re-
 sponsible individual

EPA-300 (Cin)
 (3/77)

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