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# RADIATION SAFETY MANUAL

THE

CATHOLIC UNIVERSITY  
of  
AMERICA

The Catholic University of America

Decommissioning Plan

Appendix G

JANUARY 1992

EMERGENCY PROCEDURES ARE LOCATED IN SECTION 5

THIS PUBLICATION SUPERSEDES THE RADIATION SAFETY MANUAL  
OF JANUARY 1980

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# THE CATHOLIC UNIVERSITY OF AMERICA

WASHINGTON D.C. 20064

OFFICE OF THE EXECUTIVE VICE PRESIDENT

February 1, 1992

## PROMULGATION

The use of ionizing radiation is a valuable ingredient of education in science and engineering but, because it can result in damage to living organisms, it is important that all concerned be aware of the requirements for its safe use. Radiation safety is dedicated to avoiding exposure to ionizing radiation so far as possible, and to minimizing exposure which is deemed warranted. The radiation protection program for The Catholic University of America, described in this manual, has been established (1) to provide for the protection of the University population and the general public against radiation hazards associated with University possession, use, transport and disposal of radioactive material and University use of equipment which emits ionizing radiation, and (2) to provide for University compliance with applicable regulations of Federal and District of Columbia agencies.

This manual contains significant information for those who use or are responsible for the use of radioactive material or radiation-producing equipment at the University, as well as those who may be casually exposed to radiation in the course of their work (Maintenance, Housekeeping, Security and other personnel).

Under various licenses issued by the US Nuclear Regulatory Commission, The Catholic University of America is authorized to possess and use sources of ionizing radiation for non-human use. These licenses require an active Radiation Safety Committee and an organization for radiation safety. To ensure that all requirements are satisfied the University is subject to periodic inspections by the Nuclear Regulatory Commission. These inspections are thorough and include monitoring checks of laboratory areas, examination of radioactive material procurement, disposition and inventory records, personnel monitoring procedures, and a review of the qualifications and training of individual users. Serious violation of the licenses can result in penalization of the University by loss of license and/or fine.

All persons responsible for or working with sources of ionizing radiation at The Catholic University of America must comply with the provisions of this Radiation Safety Manual and the applicable regulations of the Nuclear Regulatory Commission and the District of Columbia. The Chairman of the University Radiation Safety Committee is responsible for ensuring such compliance. The University Radiation Safety Officer assists the Chairman to that end.

This edition of the manual begins to address changes in the University radiation safety program which are required to ensure compliance with significant changes which are being made in the regulations of the Nuclear Regulatory Commission. Previous editions of the manual are obsolete and may be destroyed.

Dr. Rosemary Donley, S.C.  
Executive Vice President

## PREFACE TO THE 1992 EDITION

This edition of the Radiation Safety Manual for The Catholic University of America is the first major revision since 1980. The manual is re-issued in its entirety; the 1980 edition may be destroyed. It begins to address adjustments which are necessitated by the 1991 revision to Title 10, Code of Federal Regulations, Part 20, compliance with which is required by 1 January 1993.

Although there are no major changes in procedures for the control of radioactive material, it has been necessary to make significant changes in radioactive waste management details. The assistance of Authorized Users in achieving compliance is solicited.

I shall appreciate it if errors, omissions and suggestions for improvement are brought to my attention.

Warren E. Keene, Ph.D.  
Director of Radiation Safety  
February, 1992

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TABLE I ABBREVIATIONS USED IN THE MANUAL

AII . . . . .	Annual Limit on Intake
CFR . . . . .	Code of Federal Regulations
CUA . . . . .	The Catholic University of America
DAC . . . . .	Derived Air Concentration
DC . . . . .	District of Columbia
DHHS . . . . .	U.S. Department of Health and Human Services
DOE . . . . .	U.S. Department of Energy
dpm . . . . .	Disintegrations per minute
DR . . . . .	Disposal Report (for radioactive waste)
EDTA . . . . .	Ethylenediamine tetra-acetic acid
EML . . . . .	Electronic Measurements Laboratory, DOE
GM . . . . .	Geiger-Mueller
LSC . . . . .	Liquid Scintillation Cocktail
NRC . . . . .	U.S. Nuclear Regulatory Commission
PHS . . . . .	U.S. Public Health Service
ORNL . . . . .	Oak Ridge National Laboratory
Radwaste . . . .	Radioactive waste
RG . . . . .	(NRC) Regulatory Guide
RMIC . . . . .	Radioactive Material Inventory Control
RPE . . . . .	Radiation-producing Equipment
RPM . . . . .	Radiation-producing Machinery
RSL . . . . .	Radiation Safety Laboratory
RSC . . . . .	Radiation Safety Committee
RSL . . . . .	Radiation Safety Laboratory
RSM . . . . .	Radiation Safety Manual
RSO . . . . .	Radiation Safety Officer/Office
10 CFR . . . . .	Title 10, Code of Federal Regulations





TABLE II DEFINITIONS OF SELECTED TECHNICAL TERMS

Absorbed Dose -- The energy imparted by ionizing radiation per unit mass of irradiated material with unit rad or gray. (1 rad = 0.01 joule/kilogram = 0.01 gray).

Airborne Radioactivity Area -- Defined by 10 CFR 20.203 and 10 CFR 20.1003.

Approved Exhaust Ventilation -- A hood, glove box, or local exhaust facility which has been approved by the RSO for work with the quantity and type of isotope to be used. Approved facilities are so-designated by printed labels attached to the unit by the RSO.

Authorization -- The authority for a CUA investigator to use radioactive material of specified type(s) and quantities for stipulated purposes; Part D of Form RSO-2, Application for Possession and Use of Radioactive Material.

Authorized User -- An individual who has been granted an Authorization by the RSO.

Bioassay -- The determination of the kind, quantity or concentration and location of radioactive material in the human body by direct (in vivo) measurement, or by analysis, in vitro, of materials excreted or removed from the body.

Byproduct Material -- Defined by 10 CFR 20.3 (a.3) and 10 CFR 20.1003.

Calibrated -- A survey meter is considered to be calibrated when it reads within 10% of the correct value at two points (approximately 1/3 and 2/3 full scale) on each range to be used, or if it reads within 20% of the correct value and a calibration curve is furnished for each range to be used.

Consumable Radioactive Material -- Radioactive material which is withdrawn incrementally from a stock container for user-determined end use.

Contaminated Casualty -- An individual who has (or is suspected to have) become internally contaminated with radioactive material by ingestion, inhalation, contact with an open wound, puncture, or contact with the eyes.

Contamination -- An unwanted presence of radioactive material on a person or object.

Decontamination -- The removal of contamination to an acceptable level.

Derived Air Concentration -- Defined by 10 CFR 20.1003

Dose -- Energy imparted per unit mass of tissue by ionizing radiation, with the unit: 1 rad (0.01 gray) = 0.01 joule/kilogram.

Dose Equivalent -- The product of absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest, with unit: 1 rem (0.01 sievert).

Emergency -- Any incident resulting from the use of one or more sources of ionizing radiation which creates an internal or external hazard to personnel.

Exposure -- Being exposed to ionizing radiation or radioactive material.

External Dose -- Defined by 10 CFR 20.1003

High Radiation Area -- An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Individual User -- Any person who works with sources of ionizing radiation under the supervision of an Authorized User.

Internal Dose -- Defined by 10 CFR 20.1003

Major Spill -- A spill which entails a risk of airborne contamination in excess of the maximum permissible concentration in restricted areas (10 CFR 20, Appendix B, Table I -- Appendix B to this manual), or external radiation exposure rates in excess of 50 mrem/h at 30 centimeters.

Potentially Exposed Personnel -- Includes at least all persons authorized to work in the same room with radioactive material. In the case of penetrating radiation (x-rays, gamma rays and neutrons) personnel occupying contiguous spaces could be included if the presence of the radioactive material could cause radiation exposure rates in excess of those permissible in unrestricted areas.

Principal Investigator -- The person who is responsible for the safe handling and use of radioactive material by him-/herself and others -- the applicant in an Application for Possession and Use of Radioactive Material. The principal investigator becomes an Authorized User on approval of the application by the RSC.

Principal User -- A person authorized by the RSC for unsupervised operation of a radiation-producing machine.

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

Radiation-Producing Machine (or Equipment) -- Any machine or equipment whose primary purpose is to produce ionizing radiation, or which produces ionizing radiation coincidental to its primary purpose, such that any portion of an individual's body could receive a dose equivalent in excess of 0.005 rem (0.05 mSv) in one hour at 5 centimeters from any accessible surface of the machine.

Radiation Worker -- An individual who is permitted to work with one or more sources of ionizing radiation on the CUA campus in accordance with the administrative procedures set forth in this manual, including Authorized Users, students and employees.

Radioactive Material -- Material which emits alpha particles, beta particles, gamma rays x-rays, neutrons, high-speed electrons, high-speed protons, or other atomic particles capable of producing ionization.

Radioactive Waste -- (1) Unsealed radioactive material whose retention is no longer desired by the responsible Authorized User, (2) Material/equipment presumed to be contaminated because of its prior use with radioactive material, or (3) Sealed sources which are leaking and not economically repairable, decayed below useful activity level, or surplus with value less than \$500.00.

Recirculating Air System -- A ventilation system in which a nominal fraction of exhaust air from a room is mixed with fresh air and returned to the same and/or other rooms as supply air.

Rem -- The special unit of dose equivalent (1 rem = 0.01 sievert).

Restricted Area -- Any area access to which is controlled for the purpose of protecting individuals from exposure to ionizing radiation or radioactive material.

Source of Ionizing Radiation -- (1) Any isotope, in whatever chemical or physical form, which is naturally radioactive or has been rendered artificially radioactive, and whose quantity, total activity, or specific activity exceeds the limits established by law or regulation for exemption from controls established to protect the public health, or (2) Any radiation-producing machine or equipment, as defined herein.

Source Material -- Defined by 10 CFR 20.3 (a.15) and 10 CFR 20.1003.

Special Nuclear Material -- Defined by 10 CFR 20.3 (a.16) and 10 CFR 20.1003.

Stock Container -- A bulk or storage container from which material is withdrawn for use in a specific procedure.

Survey -- Measurement of levels of radiation exposure or concentrations of radioactive material present in uncontrolled for and disposition.

Technical Member -- A member of the Radiation Safety Committee, qualified by training and experience in the use of radioactive material or radiation-producing machines, appointed from a Department or Laboratory which makes use of sources of ionizing radiation.

Technician -- An individual who is authorized to operate a radiation-producing machine under the supervision of a Principal User.

Unrestricted Area -- An area is unrestricted and does not require control measures for exposure to external radiation if an individual continually present in the area cannot receive a dose equivalent in excess of 2 mrem in any one hour to any portion of the individual's body.

Unsealed Container -- A container of radioactive material which is open to the atmosphere or which has a closure intended for manual manipulation.

User -- A person who works with radioactive material under the direct or general supervision of an Authorized User.

## CHAPTER 1

## ORGANIZATION FOR RADIATION SAFETY

## 1.1 INTRODUCTION

The organization for radiation safety at The Catholic University of America consists of the Radiation Safety Committee, a Radiation Safety Officer who operates the Radiation Safety Office and assists the RSC in discharging its responsibilities, the Deans, Department Chairmen and Laboratory Directors within whose jurisdictions work with sources of ionizing radiation is conducted, Authorized Users who receive their authorizations from the RSC, and other members of the University community who work under the supervision of Authorized Users.

## 1.2 RADIATION SAFETY COMMITTEE

1.2.1 Establishment

The Radiation Safety Committee of The Catholic University of America was established by the Executive Vice President. The purpose of the RSC is to ensure that all sources of ionizing radiation at CUA are used safely and in a manner which complies with applicable regulations of the Federal Government and the Government of the District of Columbia, so that the individual user, the University population and the general public are protected.

The RSC reports through its chairman to the Executive Vice President and directs the operations of the University Radiation Safety Officer.

1.2.2 Responsibilities

The Radiation Safety Committee shall:

- a. Periodically review the University Radiation Protection Program and recommend appropriate changes to the Executive Vice President;
- b. Ensure the observance of all applicable regulations of Federal and District of Columbia agencies and this University;
- c. Assure that each investigator who uses radioactive materials or radiation-producing equipment is qualified by training and experience, has the facilities to use the material or equipment safely, and proposes a use which is safe for all concerned;
- d. Review all instances of alleged infractions of regulations for the safe use of sources of ionizing radiation and recommend remedial action if appropriate (This responsibility extends to on-campus projects conducted by non-University organizations or individuals);



e. Ensure the maintenance of all records required by law or regulation because of the presence or use of sources of ionizing radiation on the campus.

### 1.2.3 Authority

To meet its responsibilities, the RSC is given the following authority:

a. To grant or deny authorization to an individual, or to any University or non-University organization, for the use on CUA property of radioactive material, or radiation-producing equipment;

b. To prescribe the conditions of use on CUA property of sources of ionizing radiation, including requirements for bioassay and/or physical examinations of users, special effluent control devices, minimum level of user training and experience, restrictions on the amount of occupational exposure which an individual may be permitted to receive during his or her CUA association;

c. To suspend or terminate any project or procedure on CUA property involving the use of sources of ionizing radiation which it finds to be a threat to health or property.

### 1.2.4 Membership

The RSC consists of the Chairman and additional members as indicated below. Appointments to the RSC are made by the Executive Vice President with the advice of Department Chairmen, Deans and the RSC. Appendix A contains the names, addresses and telephone numbers of the members of the RSC.

#### a. Ex-Officio Members

Chair  
Director of Public Safety  
Representative from Health Science or Nursing Faculty  
Representative from Maintenance and Operations  
Radiation Safety Officer

#### b. Technical Members

One member, qualified by training and experience in the use of radioactive material or radiation-producing equipment is appointed from each Department which makes extensive use of sources of ionizing radiation.

### 1.2.5 Meetings

The RSC shall meet at least once per semester and at least monthly if a proposal for the use of a source of ionizing radiation is pending RSC review. An affirmative vote of a majority of the members is required to approve an application for use of a source of ionizing radiation.

### 1.2.6 Records

The formal record of the RSC is the minutes of its meetings. The minutes shall contain a record of all recommendations and actions of the RSC, together with such additional material as the Chair shall deem appropriate to completeness. The minutes shall be maintained as a permanent record of the University by the Chair and the file shall be passed from Chair to Chair.

## 1.3 RADIATION SAFETY OFFICER

### 1.3.1 Appointment

The RSO is a staff officer of the University, who is appointed by the Executive Vice President and functions under the technical direction of the RSC Chair.

### 1.3.2 Responsibilities

The RSO shall implement the CUA Radiation Safety Program. To that end the RSO shall:

- a. Periodically review the CUA Radiation Protection Program and recommend, for RSC consideration, appropriate changes in order to maintain the program in compliance with applicable regulations and the radiation exposure of radiation workers and the general public as low as is reasonably achievable;
- b. Control the procurement, transport, storage, use and disposal of radioactive material and radiation-producing equipment for the University;
- c. Determine the suitability of space, facilities or equipment for the storage or use of radioactive materials;
- d. Ensure that all CUA facilities which relate to the presence of sources of ionizing radiation on the campus are inspected and surveyed or monitored to determine compliance with regulations and radiation protection standards;
- e. Ensure that periodic leak tests are performed as required on all sealed sources of ionizing radiation owned or possessed by the University or used on the campus;
- f. Provide appropriate personnel radiation exposure monitoring devices and radiation survey instruments;
- g. Ensure that any reported or suspected radiation hazard, incident, or overexposure at CUA is investigated, reported as may be required and corrected if necessary;

h. Maintain all records pertinent to the radiation protection program which may be required by law or the efficient operation of the Radiation Safety Office, to include:

- o Receipt, distribution and disposal of radioactive material,
- o Inventory of radioactive material and radiation-producing equipment,
- o Radiation surveys and leak tests of sealed sources,
- o Registry of radiation workers,
- o Radiation exposure,
- o Licenses for CUA possession and use of radioactive material;

i. Prepare all reports required by law or regulation as a result of CUA possession and use of sources of ionizing radiation;

j. Assist users of sources of ionizing radiation in their programs by:

(1) Reviewing their plans for research and test programs involving use of sources of ionizing radiation,

(2) Providing consultation on laboratory design, shielding, and other radiation exposure control methods,

(3) Reviewing all applications for new or amended authorizations and submitting comments and recommendations thereon to the RSC,

(4) Preparing timely applications for renewal or amendment of CUA licenses for the possession and use of radioactive material,

(5) Assisting in the development of appropriate radiation safety procedures,

(6) Providing calibration and minor repair service for radiation survey instruments,

(7) Providing appropriate signs for restricted areas,

(8) Providing supervision and assistance with respect to radiation emergencies and special decontamination procedures,

(9) Reporting all instances of non-compliance with regulations for the control of sources of ionizing radiation to the RSC,

(10) Recommending remedial action to correct radiation safety infractions;

v. Operate the CUA Radiation Safety Laboratory to provide the technical support required to discharge other RSC responsibilities. The RSL may also be used for the conduct of research by or under the supervision of the RSO, subject to the same requirements for RSC authorization as are established for other CUA users of sources of ionizing radiation.

### 1.3.3. Authority

To discharge assigned responsibilities, the RSO is granted the following authority:

- a. To enter any space where a source of ionizing radiation is stored or used;
- b. To seize any radioactive material which is being stored or used in a manner which is perceived to represent a threat to persons or property;
- c. To suspend any operation with a source of ionizing radiation which is in violation of the user's authorization;
- d. To deny permission to procure radioactive material to any user whose radioactive material inventory is not current.

## 1.4 DEANS, DEPARTMENT CHAIRS AND LABORATORY DIRECTORS

Deans, Department Chairs and Laboratory Directors shall:

- a. Require compliance with applicable radiation safety regulations with respect to the personnel and facilities under their jurisdiction;
- b. Budget for and authorize necessary expenditures for radiation safety;
- c. Maintain an up-to-date list with the RSO of rooms in which radioactive material is stored or used and a list of rooms in which radiation-producing equipment is used;
- d. Maintain an up-to-date list with the RSO of personnel who may be handling radioactive material or who may be exposed to ionizing radiation to an extent greater than 10% of the values listed in Section 3.4. Students whose only handling of radioactive material occurs incident to a regularly scheduled class need not be individually named on the required list.

## 1.5 AUTHORIZED USERS

### 1.5.1 Definition

An Authorized User is defined as an individual who has been authorized by the RSC to conduct or direct a research or teaching project utilizing radioactive material or radiation-producing equipment.

The Authorized User is the key link in the organization for radiation safety. Only the Authorized User has both the expertise and the knowledge of day-to-day operations to ensure that all work is conducted safely. The remainder of the organization for radiation exists to guide and support his efforts.

#### 1.5.2 Responsibilities

Authorized Users shall conduct their work in accordance with the CUA Radiation Safety Manual and applicable Federal and DC regulations; they shall cultivate in themselves and others an awareness of the potential hazards in their research or other activities; and they shall provide adequate facilities, equipment, instruments, supervision and instructions to control radiation hazards. To assist them in the discharge of their responsibilities, further guidance is provided in Section 3.16.

#### 1.5.3 Authority

Each Authorized User has the authority, with respect to sources of ionizing radiation for which he/she is responsible, to:

- a. Suspend, pending appropriate review and instruction, the work of any employee, student, or co-worker which is perceived to be a threat to health or property or to be in violation of regulations.
- b. Take immediate possession of any source of ionizing radiation for which he/she is responsible which is being used or stored in an unsafe manner.

#### 1.6 ALL MEMBERS OF THE UNIVERSITY COMMUNITY

All members of the University community who use radioactive material or radiation-emitting equipment shall work in accordance with accepted radiation safety practices, observe the radiation safety rules and regulations in this manual, report unsatisfactory conditions (and make appropriate suggestions) to Authorized Users, Department Chairs or the RSO, and obtain guidance from an Authorized User before undertaking work with radioactive material.

## CHAPTER 2

## ADMINISTRATIVE PROCEDURES

## 2.1 INTRODUCTION

The administrative procedures prescribed herein are intended to facilitate University compliance with applicable regulations for the control of radioactive material and exposure to ionizing radiation. Authorized Users are required to comply with these procedures. Any individual who observes practices or conditions with respect to radioactive material or radiation-emitting equipment which are believed to be unsafe should bring them to the attention of the cognizant Authorized User, Department Chairman or Laboratory Director. If the matter can not be resolved satisfactorily at this level or the cognizant individual is unknown or unavailable the RSO should be contacted. In addition, any individual who believes that there is a violation of the Atomic Energy Act of 1954, the regulations thereunder or the terms of the University's licenses with regard to radiological safety conditions, may request an inspection by notifying Region I, Office of Inspection and Enforcement, US Nuclear Regulatory Commission, 475 Allendale Road, King of Prussia, Pennsylvania 19406, by letter or telephone (collect calls are accepted at (215) 337-5000). The request must set forth the specific grounds for the notice and the complainant must identify himself in the letter or telephone call.

Form NRC-3 NOTICE TO EMPLOYEES (Appendix F) is required to be posted conspicuously in or near each area which has been designated "restricted" for the purpose of radiation exposure control. It is available from the RSO, full size, or may be reproduced from the reduced copy in the appendix.

Publications which are required by law or regulation to be made available to radiation workers are listed in Appendix E. They are available for inspection in the Radiation Safety Office, together with other publications which may be useful for planning for the safe use of sources of ionizing radiation.

## 2.2 AUTHORITY TO POSSESS AND USE RADIOACTIVE MATERIAL

2.2.1 Introduction

No one may bring onto CUA property any radioactive material in amounts which would ordinarily require a specific license from the NRC without authorization from the RSO. A separate application is required for each project which contemplates the use of radioactive material; the scope of an application is the prerogative of the applicant; the scope of an authorization will be determined by the RSO based on its evaluation of the information provided, and the training, experience and facilities of the applicant.



### 2.2.2 Application for Authority to Possess and Use Radioactive Material

Application shall be made on Form RSO-2 (Appendix F). Copies of the form are available from the RSO. Reapplication must be made when an increase in the authorized amount of activity of a previously approved isotope is desired, when a significant change of equipment or procedure is desired, or when additional isotopes are to be used. Instructions to the applicant for completing Form RSO-2 are contained in Appendix G.

### 2.2.3 Review of Applications

Review shall be conducted in a manner which:

- o Ensures the radiological safety of the University community,
- o Ensures compliance with applicable laws, regulations and licenses, and
- o Facilitates the work of competent researchers.

#### a. RSO Review

Each application shall be reviewed by the RSO who shall, within two weeks of its receipt in final form:

- o Complete Section II, Parts A & B, with his comments and recommendations and forward it to the RSC, or
- o Advise the applicant and the RSC Chairman that review can not be completed within two weeks, the reasons therefor, and the estimated date of completion, or
- o Return the application to the applicant with a request for specific revisions.

When the RSO has returned an application for revision, the applicant may:

- o Make the suggested revision(s), or
- o Return the application to the RSO with reasons for disagreeing with his recommendation(s).

The RSO shall then forward the application to the RSC together with his comments and recommendations. Unless amended by the RSC, the recommendations of the RSO shall be binding on the applicant.

#### b. RSC Review

In order to afford RSC members time for careful consideration and to provide timely service to applicants, the RSC shall meet to review an

application not earlier than one week nor later than one month after the application, together with the RSO's comments, has been distributed to committee members. When RSC review cannot be completed within one month, the Chair shall advise the applicant in writing of the reasons therefor and the estimated date of completion of the review. As a result of its review the RSC may:

- o Approve the application and the recommendations of the RSO, amended as it may find appropriate; or
- o Reject the application.

On approval by the RSC, an authorization number and expiration date shall be assigned. One copy of the application endorsed by the RSC Chairman shall be returned to the applicant, one copy shall be provided to the RSO and one copy shall be retained in the Chairman's files. If an application is rejected the record shall show the reason(s) therefor, which shall be communicated by the Chairman, in writing, to the applicant.

#### 2.2.4 Criteria for Approval of Applications

The RSO and the RSC are concerned only with safety and regulatory compliance and not with the technical merit of the proposed use of radioactive material. Their review is to determine whether:

- a. The applicant has the necessary training and qualifications to conduct the proposed operation safely;
- b. The applicant has the necessary facilities and equipment to use the radioactive materials safely and in a manner which will comply with applicable regulations;
- c. Amendment of CUA license(s) is required before commencement of the proposed operation.

#### 2.2.5 Termination of Authorizations

All authorizations by the RSC shall terminate automatically at the termination date assigned, which normally will be two years from the first day of the month following approval. It is the responsibility of the Authorized User to submit a timely request for extension of ongoing programs.

The Authorized User shall notify the RSO at least 30 days prior to the termination of an authorized use of radioactive material. The RSO shall ensure that the area and facilities are surveyed thoroughly and advise the Authorized User and the cognizant administrator whether the area may be reverted to unrestricted use.

## 2.3 CONTROL OF RADIATION EXPOSURE OF INDIVIDUALS

### 2.3.1 Radiation Exposure History

An attempt shall be made by the RSO to determine the prior radiation exposure history of each Authorized User.

### 2.3.2 Medical Examinations

Individuals desiring to undertake work with radioactive materials may be required by the RSC to undergo medical examination. Depending on the individual's exposure history, such tests as urine bioassays, controlled background body-burden measurements and radon or carbon-14 breath tests may be required.

### 2.3.3 Personal Monitoring Services

Each individual who enters a restricted area under such circumstances that he receives or is likely to receive a whole body dose in excess of 100 millirem (50 millirem if under age 18) in any calendar quarter, or in excess of 5 millirem in any one day, shall be monitored for actual radiation exposure as indicated below.

The RSO shall provide appropriate monitoring devices or services and maintain a record of the doses or body burdens recorded. Department Chairs and Laboratory Directors shall ensure the utilization of such devices and services.

#### a. Film and Ring Badges

Film badges shall be provided by the RSO to those individuals who regularly work with or in the vicinity of sources of nuclear radiation which emit beta particles of energy greater than 0.2 MeV, x-rays, gamma rays or neutrons. Film badges are normally processed on a monthly basis and readings which exceed minimum detectable (10 mrem) are reported to the individual concerned (and to the responsible supervisor if considered appropriate by the RSO) upon receipt of the readings from the contractor.

A departmental representative shall be appointed by the Department Chair to distribute, collect and forward film and ring badges to the RSO. In order to preclude unnecessary special service charges by the commercial supplier, film and ring badges shall be returned to the RSO prior to the 10th of each month.

The use of one or more ring badge dosimeters may be required by the RSC during operations in which the dose to the hands and forearms is likely to be significantly in excess of the whole-body dose. Ring badges shall be provided by the RSO when required.

#### b. Pocket Dosimeters

Pocket dosimeters shall be worn (in addition to a film badge, if provided) if a whole-body dose in excess of 5 mrem is likely in any one day. A

log of pocket dosimeter readings made prior to entry into the radiation area, and the readings on exit from that area, shall be maintained by the facility which requires their use. A monthly summary of readings in excess of 10 mrem shall be furnished to the RSO.

c. Bioassay

Bioassay is the determination of the kind, quantity or concentration, and location of radioactive material in the human body by direct (in vivo) measurement or by analysis in vitro of materials excreted or removed from the body. Depending on the nature of the material and the circumstances, uptake may occur by inhalation, ingestion (swallowing), skin puncture or diffusion through the skin. All suspected uptakes shall be reported immediately to the RSO who shall provide or arrange for appropriate bioassay services.

(1) Special Bioassay Requirements for Tritium

All persons who handle individual tritium sources (in any chemical or physical form other than in sealed containers) whose activity exceeds 5 millicuries shall submit urine samples to the RSO for bioassay. The frequency of bioassay shall be established by the RSC and stated in the User's Authorization. The required frequency shall be no less than that recommended by "Guidelines for Bioassay Requirements for Tritium" (NRC, Oct 77) or the appropriate successor publication.

(2) Special Bioassay Requirements for Iodine

NRC Regulatory Guide 8.20 suggests that bioassays be performed for individuals who handle unsealed quantities of I-125 or I-131 which exceed certain amounts specified under various working conditions. Because experimental use of radioactive iodine may involve less certainty as to the form of the material at each step in a process than would standardized operations, and to ensure compliance with RG 8.20 under all experimental circumstances, bioassay services shall be performed for all individuals who handle at CUA unsealed quantities of I-125 or I-131 which exceed 0.1 millicuries. The RSO is authorized to relax this requirement (in a manner consistent with R.G. 8.20) on the basis of the bioassay history of individual users.

d. Special precautions for Pregnant Women

Department Chairs, Laboratory Directors and Authorized Users shall ensure that women under their jurisdiction who work with sources of ionizing radiation are aware that radiation exposure of the fetus may increase the risk of childhood leukemia. The NRC has published a general guide on this subject. It is reprinted in Appendix C to this manual. (See also Sections 3.4.1 & 3.16 j(2).)

## 2.4 PROCUREMENT OF SOURCES OF IONIZING RADIATION

2.4.1 Radioactive Materiala. Acquisition

Requests for procurement of all sources of ionizing radiation, whether radiation-producing machines, byproduct, source or special nuclear material, accelerator or artificially produced radioactive material, or radium or other naturally occurring radioactive materials, shall be submitted to the RSO for approval.

Exempt from this requirement are consumer devices which have been exempted from NRC licensing, all materials of atomic number less than 83 whose only radioactivity is that occurring at natural background levels, and all materials of atomic number greater than 82 contained as background-level contaminants in other material.

The RSO shall approve such requests and transmit them to the CUA Purchasing Department (or other appropriate addressee) provided:

- (1) The originator has an approved authorization for the source on file with the RSO,
- (2) The activity requested, in the case of radioactive material, will not result in exceeding the user's limits or the limits provided in the applicable CUA license, and
- (3) The Authorized User's isotope inventory on file with the RSO is current.

b. Preparation of Requisitions

Requisitions for radioactive material shall be prepared in the usual manner on the standard CUA requisition form except that such requisitions shall not contain requests for non-radioactive materials or laboratory supplies. A copy of the requisition shall be included for retention by the RSO as part of the permanent records of the office. Requisitions for radioactive material shall include the following information:

- (1) The words "RADIOACTIVE MATERIAL ORDER",
- (2) The identity of the Authorized User and his authorization number,
- (3) The symbol and mass number of each radionuclide, its chemical or physical form and the amount of activity ordered, expressed in curies or becquerels (or standard multiples thereof).

## 2.4.2 Radiation-Producing Machines and Equipment

### a. Definition

A radiation-producing machine is any equipment whose primary purpose is to produce ionizing radiation, or which produces ionizing radiation coincidental to its primary purpose such that the exposure exceeds 0.5 mrem/h at 5 cm from any accessible surface.

### b. Policy

Before acquiring any radiation-producing machine (whether by purchase, loan, consignment for evaluation, or other means), the individual who is to be primarily responsible for its use shall consult with the RSO to determine whether any special restrictions will be necessary and to acquaint himself or herself with applicable regulations.

### c. Procedure

(1) The responsible individual shall provide to the RSO a copy of the purchase order or other acquisition document.

(2) The RSO shall be notified immediately upon receipt of a radiation-producing machine and supplied with the necessary information for registration with the government of the District of Columbia, if registration is required.

(3) The RSO shall be present to survey the machine at its initial testing and at such additional testing periods as may be required to satisfactorily characterize the radiation field under all operational modes.

## 2.5 PROPOSALS FOR CONTRACTS AND GRANTS INVOLVING IONIZING RADIATION

### 2.5.1 Investigator Responsibilities

Each proposal for or solicitation of support (of whatever form, such as a contract, grant, gift, etc.) for research which anticipates the use of radioactive material or other sources of ionizing radiation shall be submitted to the RSO for review prior to submittal to the Director of Sponsored Programs and Research Services. The purpose of the RSO review is to ensure that the proposal budget includes the cost of such radiation monitoring and protection devices and equipment as may be appropriate (if not already at hand), and to evaluate the prospective impact of the proposal on the RSO operating budget. The investigator submitting the proposal is urged to involve the RSO sufficiently early in its preparation that agreement may be reached with respect to the required equipment and facilities. Any disagreement which cannot be resolved between the investigator and the RSO shall be referred in writing to the Chair of the RSC for resolution by the Committee, whose decision shall be binding.



### 1.5.2 RSO Responsibilities

The RSO shall endorse each proposal submitted to him for review to the effect that:

a. Adequate provision has (or has not) been made in the proposal budget for the cost of appropriate radiation safety measures.

b. Augmentation of the RSO budget will (or will not) be required in order to provide necessary radiation safety support services to the investigator if the contract sought is awarded. If budget augmentation is expected to be required, the RSO shall append to the endorsement a supporting budget impact analysis. A copy of the analysis shall be provided to the Chair, RSC.

## 2.6 RECEIVING SHIPMENTS OF RADIATION SOURCES

### 2.6.1 Consignments

Shipments of radioactive material intended for Authorized Users at CUA shall be consigned to:

The Catholic University of America  
Radiation Safety Office  
B-18A Pangborn Hall  
or if not open,  
Department of Public Safety  
109 Administration Building  
620 Michigan Avenue, NE  
Washington DC 20064

In the case of bulky equipment which either produces ionizing radiation or incorporates a radioactive source, consignment shall be to the user but the RSO shall be notified promptly upon receipt and before unpackaging.

### 2.6.2 Receiving

All shipments of radioactive material arriving at CUA during normal working hours shall be delivered to the RSO; carriers attempting to deliver such material which has been erroneously consigned to a department or laboratory shall be directed to the RSO. Shipments arriving outside of normal working hours shall be accepted by the Department of Public Safety. Small packages shall be physically accepted. They shall not be retained longer than necessary in the Dispatchers Office, but shall be deposited in the Radiation Safety Office by the first available security officer. If a package is too large or too heavy to be handled conveniently by a security officer, the delivering truck shall be escorted to Pangborn Hall by a security officer so that the package can be off-loaded directly to the Radiation Safety Office.

### 2.6.3 Logging

The RSO shall maintain a log of all incoming radioactive material in which is indicated the date of receipt, the symbol and mass number of the isotope and its chemical or physical form, the activity, the supplier, the Authorized User, and the user's receipt for the material.

### 2.6.4 Inspection

All incoming shipments of radioactive material shall be inspected by the RSO in accordance with 10 CFR 20.1906.

### 2.6.5 Delivery to Authorized User

Upon satisfactory completion of the arrival inspection, the RSO shall deliver the material or inform the Authorized User (or his Departmental or Laboratory office) of its availability for pickup. The User or designated representative shall receipt for the material on the form provided by the RSO.

## 2.7 OUTGOING SHIPMENTS OF RADIOACTIVE MATERIAL

No individual or organization, except the RSO, is authorized to ship or transport radioactive material from a campus location to an off-campus location. Exempt from this requirement are consumer devices which have been exempted from NRC licensing, all materials of atomic number less than 83 whose only radioactivity is that occurring at natural background levels, and all materials of atomic number greater than 82 contained as background-level contaminants in other material.

Authorized Users desiring to use CUA-possessed radioactive material at an off-campus site shall contact the RSO who shall ensure that appropriate arrangements are made in accordance with University licenses and applicable regulations. Authorized Users anticipating such a requirement are cautioned to allow considerable lead time, since an amendment to a license may be required.

## 2.8 TRANSPORTATION OF RADIOACTIVE MATERIAL ON CAMPUS

Radioactive material may be hand-carried outside of restricted areas, and between buildings on-campus, provided that the following conditions are met:

a. The material is enclosed within a shatter-proof container which is properly labeled,

b. The radiation exposure does not exceed either 20 mrem/h at the surface of the container or 5 mrem/h at a distance of one meter from the container surface,

c. There is no detectable contamination of the container's exterior surface as determined by a wipe test and survey meter measurement of the wipe test, and

d. During transit, the radioactive material is in the continuous possession of an individual who is authorized to use or transport the material.

## 2.9 INVENTORY OF SOURCES OF IONIZING RADIATION

### 2.9.1 Policy

Licenses granted the University by the NRC impose total possession limits for radioactive material by element name and mass number, and by chemical or physical form. Certain naturally occurring radioactive materials and much equipment which produces ionizing radiation is not subject to federal or local government license requirements. However, in order to ensure that the University both remains in compliance with the possession limits imposed by license(s) and to protect the health and safety of the University community, the RSO shall maintain a running inventory of all sources of ionizing radiation (as defined by Table II) on the campus, or possessed by University Departments or Laboratories at other authorized locations. Exempt from this requirement are consumer-type devices which contain small quantities of radioactive material or emit small quantities of radiation and which have been exempted from license control (e.g., watches, instrument dials, cathode ray tubes, etc.). Also exempt are all materials (except source material and special nuclear material) whose only radioactivity is that occurring at natural background levels.

In order to provide the RSO with the information required to carry out this duty, the inventory control procedures described in the following sections shall be followed by all Authorized Users of sources of ionizing radiation.

### 2.9.2 Consumable Radioactive Material

#### a. Definition

Consumable radioactive material is defined, for inventory control purposes, as radioactive material which is withdrawn incrementally from a stock container for user-determined end use.

#### b. Radioactive Material Inventory Control Number

A radioactive material control number (RMIC) shall be assigned by the RSO to each container of consumable radioactive material received. The RMIC number shall be permanently affixed by the Authorized User to each stock container and shall be used in identifying the material in all inventory records. (The user may, in addition, have his own identification of the material.) If the contents of the original container are partitioned into two or more stock containers, each shall have permanently affixed the RMIC number and a letter suffix. A stock container whose residual contents are expected to be disposed of to radwaste in less than one month need not be assigned a RMIC suffix.

c. Radioactive Material Inventory Control Form (RSO-1)

Form RSO-1 (Appendix F) shall be prepared in duplicate by the RSO for each container of consumable radioactive material received. The original will be used to maintain the RSO master inventory; the copy will be delivered to the Authorized User with the radioactive material. The Authorized User shall maintain the form current by recording the date, quantity and disposition of each withdrawal from the container. The Authorized User shall prepare (with copy to the RSO) and maintain current a separate RMIC form for each stock container assigned a RMIC suffix.

d. Radioactive Material Disposal Report

Interim disposal of consumable radioactive material into radwaste holding containers in the user's laboratory shall be recorded on the appropriate RMIC form. In addition, a running record of radioactive material deposited in each container shall be maintained. Based on these records, a Radioactive Material Disposal Report shall be prepared and shall be delivered to the RSO with each lot of radwaste. The disposal report shall show the total activity in millicuries for each chemical species and mass number included in each container of radwaste.

2.9.3 Sealed Sources

Sealed radioactive sources, and other radioactive material which is not intended to be consumed by incremental experimental use (such as liquid scintillation standards or other liquid reference standards) shall be recorded on a master inventory by each Department or independent Laboratory. Form RSO-3 (Appendix F) shall be used.

2.9.4 Radiation-Producing Equipment

A detailed description of each radiation-producing machine, as defined in Table II, shall be provided the RSO by the using Department. As a minimum, the information provided shall include:

- a. The manufacturer's name, address, telephone number and local representative, if any;
- b. The name, model number and serial number of the unit;
- c. The nature and intensity of the radiation emitted;
- d. Whether the radiation field is confined within the equipment or extends outside the equipment:
  - (1) During normal operation, and
  - (2) When the equipment is accessed for maintenance;

- e. In the case of equipment intended to produce an ionizing radiation field external to the equipment, the field shall be sufficiently characterized to permit assessment of the radiological health implications of its use;
- f. Identification of safety devices incorporated to protect the operator and others from the harmful effects of such radiation.

## 2.10 INTER-USER TRANSFER OF RADIOACTIVE MATERIAL

### 2.10.1 Policy

Radioactive material and radiation-producing machines (as defined in Table II) shall be transferred between Authorized Users only with the prior knowledge and approval of the RSO.

### 2.10.2 Procedure

Radioactive material to be transferred shall be taken to the Radiation Safety Office where each container will be logged in, checked for external contamination, removed from the RMIC record of the former Authorized User and a RMIC form prepared for the new Authorized User in accordance with Section 2.9.2.

## 2.11 DISPOSAL OF RADIOACTIVE WASTE

### 2.11.1 Policy

No radwaste may be disposed of by conventional methods. This means particularly that solid radwaste may not be placed in the standard waste containers to be collected by housekeeping personnel and that liquid radwaste shall not be discharged into the sewer. Incineration and burial of radwaste on the CUA campus are prohibited. Radwaste contaminated only with short-lived isotopes will be collected by the RSO and held for decay in accordance with the provisions of applicable licenses. After decay, radioactive markings will be removed or obliterated, surveyed to confirm the absence of detectable radioactivity and disposed of to ordinary trash.

Radioactive material combined with or in the form of material which is either hazardous, (such as toxic chemicals, live viruses, aflatoxin, etc.) shall not be disposed of by any of the means herein authorized without prior authorization from the RSO in each instance. The Authorized User shall advise the RSO of proposed experiments involving these or other unusual radwaste disposal problems prior to initiation of the experiments. The RSO, after consultation with the RSC and the Director of Environmental Safety, shall furnish appropriate guidance to the Authorized User.



### 2.11.2 Procedure

Authorized Users shall store and dispose of radwaste only in accordance with the detailed procedures set forth in Appendix D. The RSO shall arrange with the appropriate agency of the Government of the District of Columbia, or contract with a licensed commercial firm, for removal and lawful disposition of all CUA radwaste which is not released to the sewer or to the atmosphere. In the event that access to a licensed low level waste site is denied, the RSO shall store radwaste in the CUA radwaste storage and handling facility until access is restored.

## 2.12 CORRECTIVE ACTION

It is anticipated that most questions of radiological safety will be resolved by action determined in consultation between an Authorized User and the RSO. To ensure that the safety of users and the public can be protected, the RSO has been granted the authority to take possession of any radioactive material or suspend any procedure or operation involving the use of radioactive material or radiation producing machines which is believed to pose a radiological threat to health or property. Such action shall be reported promptly by the RSO to the RSC Chairman.

### 2.12.1 Radiation Safety Committee Responsibility

The Radiation Safety Committee shall:

- a. Review and confirm, modify or vitiate, for the record, all peremptory corrective action taken by the RSO;
- b. Review all allegations, by whatever party, of infractions or unsafe practices involving the possession or use of sources of ionizing radiation. The RSC may require that such allegations be placed in writing and shall respond in writing thereto;
- c. Take corrective action, if required, which may include:
  - (1) Requiring additional training of personnel prior to permitting resumption of their work under a User Authorization,
  - (2) Alteration of the terms of a User Authorization,
  - (3) Suspension of a User Authorization, or
  - (4) Recommending administrative discipline to the Executive Vice President.

### 2.12.2 Right of Appeal

The action of the RSC may be appealed to the Executive Vice President and ultimately to the President, by the originator of allegations brought under

Section 2.1 or Section 2.12.1, or by a User in disagreement with the actin of the RSC. Such appeals shall be in writing and shall set forth succinctly the factual basis for the appeal.

## 2.13 EDUCATION AND TRAINING FOR RADIATION SAFETY

The Radiation Safety training team consists of the RSO, the Departmental RSC representative and the Authorized User. Each brings different training and experience to bear on the problem of radiation safety. It is expected that they shall work together to ensure the adequacy of the radiation safety training of CUA radiation workers, as well as students whose only use of ionizing radiation may be in a closely supervised laboratory course. To assist them in sharing the University's obligation to provide radiation safety training, this section imposes on each of them certain responsibilities which partially overlap.

### 2.13.1 Responsibility of the RSO

The RSO shall ensure that education and training of CUA radiation workers required by law, regulation, or safety considerations, is accomplished to an extent consistent with their work. To this end he shall, as appropriate:

- a. Supplement the prior training of applicants for authorization to use radioactive material or radiation-producing machines in order to assist them to qualify themselves for work they desire to undertake;
- b. At the request of a Departmental RSC representative or Authorized User, conduct or assist in training for radiation workers;
- c. Maintain a record of such training conducted by himself, Departmental RSC representatives and Authorized Users;
- d. Acquire and maintain current a collection of radiation safety related reference publications consistent with the nature and extent of the use of ionizing radiation at CUA.

### 2.13.2 Responsibility of Departmental RSC Representatives

Within each department the overall responsibility for ensuring the radiological safety education and protection of CUA personnel using, or in the proximity of the use of, sources of ionizing radiation rests with Departmental RSC representative. He/she shall:

- a. Ensure that each Authorized User within the department provides appropriate radiation safety instruction of all radiation workers for whose work and safety he is responsible;
- b. When necessary or desirable, conduct or assist in conducting radiation safety training for departmental radiation workers;



c. Keep the RSO informed regarding the need for and the accomplishment of radiation safety training.

### 2.13.3 Responsibility of Authorized Users

Each Authorized User is directly responsible for the safe use of radioactive material and radiation-producing equipment for which he is responsible by all persons who may be permitted to use them. He/she shall:

a. Ensure that they have obtained the training and indoctrination required to enable safe working habits and to maintain the radiation dose to themselves and others as low as is reasonably achievable;

b. Teach those for whose radiological safety they are responsible (by instruction and example) the use of safe techniques and the application of approved radiation safety practices;

c. Enlist the assistance, as appropriate, of the RSO, the Departmental RSC representative, or others, in training their radiation workers in matters of radiation safety;

d. Maintain a record of the radiation safety training of each individual concerned (The record need not include incidental instruction of students whose only use of radioactive material or radiation-producing equipment is in a regularly scheduled laboratory course under the direct supervision of appropriately trained individuals);

e. For educational or safety purposes, consider the advisability of conducting (or requiring others to conduct) experimental procedures "cold", to ensure that the envisaged procedures are sound, before they are performed with dispersible radioactive material. (The RSC may so-require by the terms of a User's Authorization.).

## 2.14 INCIDENT AND EMERGENCY REPORTING

### 2.14.1 Authorized User Responsibility

Each Authorized User shall notify the RSO immediately of the following types of incidents involving sources of ionizing radiation subject to his control:

- a. Possible personnel contamination by or ingestion of radioactive material;
- b. Suspected overexposure to radiation;
- c. Unanticipated contamination of equipment or facilities;
- d. Misplacement, loss, or suspected theft of radioactive material.

Any other individual (including co-workers, subordinates or students) possessing such information shall communicate it immediately to the Authorized User, if known and available. If the responsible Authorized User is unknown or unavailable, the individual shall notify the RSO.

#### 2.14.2 RSO Responsibility

The RSO shall investigate all reports of incidents involving ionizing radiation. He shall inform the Chairman of the RSC of his findings and recommendations. The RSO shall prepare, for the signature of the RSC Chairman any notification to the NRC, or other regulatory agency, required by law or regulation concerning such incident. Prior to making a telephonic or telegraphic notice to the NRC (if such is required), the RSO shall advise the most junior of the following University Officials who can be reached: The RSC Chairman, the Executive Vice President or the President. If none of these can be contacted, the RSO shall make the required notification, take charge of the emergency situation which required the notice and inform the indicated University officials as soon as practicable.

## CHAPTER 3

## RULES FOR CONTROL AND MONITORING OF PERSONNEL EXPOSURE AND ENVIRONMENTAL RADIATION

## 3.1 INTRODUCTION

This chapter sets forth rules which are intended to assist Authorized Users in conducting their work safely, in compliance with applicable regulations, and in a manner which will ensure that exposures to ionizing radiation are maintained as low as is reasonably achievable. These rules are an implied part of each User's Authorization granted by the RSC.

## 3.2 ACCESS CONTROL

Federal regulations define areas containing ionizing radiation which do and do not require special control measures and which specify maximum levels of exposure in controlled areas.

3.2.1 Unrestricted Area

An area is unrestricted and does not require control measures for exposure from external radiation if an individual continually present in the area cannot receive a dose in excess of 2 mrem in any one hour.

3.2.2 Restricted Area

When an area contains radiation exposure levels above those allowable for unrestricted areas or is used for storage or use of radioactive materials in excess of the quantities stipulated in Section 3.3 it shall be designated a "restricted" area; access shall be controlled by the responsible Authorized User so that exposure to individuals is less than the limits specified in Section 3.4; and it shall be posted in accordance with Section 3.3.

"RESTRICTED AREA" means an area access to which is limited for the purpose of protecting individuals from undue risk from exposure to ionizing radiation or radioactive materials. More than one of the sub-classifications defined below may be applicable to a restricted area.

"RADIATION AREA" means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 mrem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

"HIGH RADIATION AREA" means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 mrem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

"AIRBORNE RADIOACTIVITY AREA" means a room, enclosure or area in which airborne radioactive materials, composed wholly or partly of licensed material, exists in concentrations -- (1) In excess of the derived air concentrations (DACs) specified in Appendix B to 10 CFR 20.1001-20.2401, or (2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours. No such area shall be created by any CUA user without the express consent of the RSC.

### 3.3 POSTING OF RESTRICTED AREAS

The RSO shall furnish, and the responsible Authorized User shall post at each entrance to a restricted area, a sign bearing the radiation caution symbol, the word "CAUTION" (or "DANGER"), and one or more of the following wordings as may be appropriate: "RADIATION AREA", "HIGH RADIATION AREA", or "RADIOACTIVE MATERIAL".

The words "RADIOACTIVE MATERIAL" shall be included on the sign(s) for each room in which is used or stored radioactive material in an amount exceeding 10 times the quantity specified in Appendix C to 10 CFR 20.1001-20.2401 (Appendix B to this manual).

The name and telephone numbers (office and residence) of the responsible Authorized User of each restricted area shall be included on or adjacent to each sign required by this section.

### 3.4 PERMISSIBLE EXPOSURES IN RESTRICTED AREAS

Each Authorized User shall control his operations so that no individual over 18 years of age who is permitted to work in a restricted area under his control receives from sources in the possession of CUA a dose equivalent in excess of the limits set forth in Section 3.4.1. The exposure of individuals under 18 years of age shall be limited to 10% of these values.

NOTWITHSTANDING THE PRESCRIBED LIMITS, ALL OPERATIONS SHALL BE CONDUCTED SO AS TO MAINTAIN RADIATION DOSES AS LOW AS IS REASONABLY ACHIEVABLE

#### 3.4.1 Occupational Dose Due to External Exposure

The maximum permissible dose equivalent to the total body shall be 100 mrem per week. (The dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman should not exceed 0.5 Rem (5 mSv)). In the absence of an intake of radioactive material, Table 3.4.1 provides appropriate guidance for limiting external exposure.

TABLE 3.4.1 MAXIMUM PERMISSIBLE OCCUPATIONAL DOSE IN RESTRICTED AREAS\*

ORGAN--	WEEKLY	QUARTERLY	ANNUALLY
	Rem	Rem	Rem
Total body	0.1	1.25	5
Skin of whole body or any extremity	1.0	12.5	50
Lens of the eye	0.3	3.75	15

\*Exposure of persons under age 18 shall be less than 10% of the tabulated values.

### 3.4.2 Internal Exposure

Internal exposure, i.e. ingestion and inhalation, is controlled by appropriate work habits (Sec. 3.18), and by limiting airborne (Sec. 3.5) and surface contamination (Sec. 3.6), and measured, when necessary, by bioassay (Sec. 2.3.3.c). An annual limit on intake (ALI) is specified in the regulations, by isotope (10 CFR 20 App. B, Table 1).

### 3.5 AIRBORNE CONTAMINATION LIMITS

Airborne radioactivity concentration limits have been established to prevent overexposure of any organ in the body as a result of breathing contaminated air. The limits are specified in 10 CFR 20, Appendix B, Table I. The table lists, by isotope, the annual limit on intake (ALI) and the derived air concentration (DAC)--that concentration which, if breathed for 2000 hours, would result in inhalation of one ALI. If more than one isotope is airborne, the sum of the fractions rule is applicable.

### 3.6 SURFACE CONTAMINATION LIMITS

Surface contamination limits for restricted and unrestricted areas on the CUA campus are given in Table 3.6.1 and Table 3.6.2 (RG 8.23). These limits are subject to the following conditions and interpretations:

a. The tabulated limits are to be used as guides and, in practice, professional judgment shall be used by the RSO to determine the acceptability of the actual contamination.

b. Although it is believed that the recommended limits would not result in a health hazard, good radiation protection practice dictates that contamination levels should be kept as low as is reasonable achievable.



c. Compliance with contamination limits shall not be used as conclusive evidence that internal exposure of persons to radioactive material is within the prescribed limits. Appropriate bioassays shall be used to quantify suspected ingestion.

Table 3.6.1 REMOVABLE SURFACE CONTAMINATION LIMITS ON THE CUA CAMPUS

TYPE OF SURFACE	ALPHA EMITTERS dpm/100 cm <sup>2</sup>	BETA EMITTERS dpm/100 cm <sup>2</sup>
Unrestricted areas	22	220
Restricted areas	220	2,200
Personal clothing worn outside restricted areas	22	220
Protective clothing worn only in restricted areas	220	2,200
Skin	220	220

Table 3.6.2 ACCEPTABLE SURFACE CONTAMINATION FOR UNCONTROLLED RELEASE OF EQUIPMENT

Nuclide	Average	Maximum	Removable
U-nat, U-235, and associated decay products	5,000	15,000	1,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-125, I-131, I-133	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000	15,000	1,000

### 3.7 PERSONNEL MONITORING

Each Authorized User shall ensure that prescribed personnel monitoring devices are worn by him/herself and others for whose radiological safety he/she is responsible during all work with sources of ionizing radiation under his control, and that samples for bioassay are submitted when requested by the RSO.

### 3.8 SURVEYS

#### 3.8.1 Definitions

"Survey" is defined to mean measurement of levels of radiation exposure or concentrations of radioactive materials present in uncontrolled form and disposition.

"Unsealed container" is defined to mean any container of radioactive material which is open to the atmosphere or which has a closure intended for manual manipulation.

#### 3.8.2 Authorized User Responsibility for Surveys

The responsible Authorized User shall require that each room in which unsealed containers of radioactive material totaling in excess of 1 millicurie are used or stored is surveyed at least weekly, and daily when procedures using unsealed sources in excess of 1 mCi are performed. Wipe tests shall be used for carbon-14 and tritium. (Clean wipes are available from the RSO.) The results of User surveys shall be recorded in a suitable chronological log for each restricted area, which shall indicate the areas surveyed, the level of removable contamination measured (dpm/100 cm<sup>2</sup>) and the isotope most likely to be present.

Authorized Users not possessing appropriate equipment for counting wipes shall deliver them to the RSO for counting. The RSO shall return the counting results to the User for inclusion in the restricted area survey log.

#### 3.8.3 RSO Responsibility for Surveys

The RSO shall ensure that wipe tests and/or meter surveys, independent of those conducted by Users, are performed in all CUA restricted areas at least once per month. The results of these surveys shall be made a permanent part of the records of the RSO.

#### 3.8.4 Requirement for Area Decontamination

When a meter survey indicates a radiation exposure rate more than twice background, in the absence of known sources, that area shall be considered contaminated and a wipe test shall be made to determine the extent of the removable contamination. Decontamination shall be undertaken when removable activity is found to exceed 10% of the limits stated in Section 3.6; good practice dictates that decontamination should be undertaken as soon as practicable whenever removable contamination is demonstrated to be present.



### 3.9 LABELING CONTAINERS OF RADIOACTIVE MATERIAL

#### 3.9.1 Requirements

Each container of radioactive material which is left unattended shall bear a durable, clearly visible label bearing the radiation caution symbol, the words "CAUTION (or DANGER), RADIOACTIVE MATERIAL", the chemical species and massnumber, the quantity of activity present as of an indicated date, and the specific activity in curies per gram (or curies per cm<sup>3</sup> of liquid solution). In addition, the RMIC number shall be affixed in accordance with Section 2.9.2.

Procurement of labels is a User responsibility. The RSO can provide vendor information.

#### 3.9.2 Exceptions

Certain exceptions to the labeling requirement are authorized by 10 CFR 20.1905 and 10 CFR 20, Appendix C. In general, quantities less than 0.1 ALI and concentrations lower than those authorized for discharge to the sewer need not be labeled. However common sense suggests that all material which are intended to be used as radioactive material be descriptively labeled.

### 3.10 STORAGE OF RADIOACTIVE MATERIAL

All material which requires a "RADIOACTIVE MATERIAL" label shall be stored only in a restricted area and in a manner which provides adequate protection against fire, explosion, flooding or unauthorized removal.

Radioactive material shall be stored in a suitable container and the direct radiation from the container shall be limited by shielding in accordance with Section 3.12.

### 3.11 RADIOACTIVE WASTE

Radwaste shall be stored and disposed of only in accordance with the detailed procedures set forth in Appendix D.

### 3.12 SHIELDING SOURCES OF IONIZING RADIATION

All sources of ionizing radiation, including stock materials, in a restricted area shall be shielded so that the dose equivalent rate shall not exceed 100 mrem/h at any exposed surface of the container or shield, or 5 mr/h at 30 centimeters from any exposed surface of the container or shield. The exposure rate in the nearest unrestricted area accessible to personnel shall not exceed 0.5 mrem/h.

### 3.13 MISPLACEMENT, LOSS OR THEFT OF RADIOACTIVE MATERIAL

Discovery of the misplacement, loss or suspected theft of radioactive material shall be reported promptly to the RSO, who shall be guided by applicable regulations in notifying appropriate authorities.

### 3.14 EQUIPMENT USED FOR RADIOACTIVE WORK

#### 3.14.1 Removal of equipment from Restricted Areas

Equipment which has been used for radioactive material or which may have become contaminated by radioactive material shall not be removed from a restricted area to an unrestricted area (e.g., repair shop, machine shop, other laboratory, cleaning facility or return to vendor) until demonstrated to be free of contamination in accordance with Table 3.6.2.

#### 3.14.2 Repair of Contaminated Equipment

Equipment to be repaired or modified on site in a restricted area by University or contractor personnel shall be decontaminated, if practicable, prior to servicing. If decontamination to the levels prescribed in Section 3.6 for "Release of Material" is not practicable and the repair or modification is warranted by the value of the equipment, the work shall be directly supervised by the Authorized User who shall ensure that appropriate precautions are taken for the radiological safety of those doing the work. Users are encouraged to consult with the RSO if there is any doubt about how to proceed.

#### 3.14.3 Vacuum Systems

Vacuum lines which are built into fume hoods or which discharge into a central vacuum system shall not be used for procedures in which radioactive material could be drawn into the line. A separate vacuum pump exhausting into a fume hood which has been approved for use with radioactive materials shall be used instead; a pump exhaust filter may be required. A pump, once so-used, shall be considered contaminated until demonstrated otherwise.

### 3.15 SURVEY INSTRUMENTS

#### 3.15.1 Procurement

The RSO shall furnish appropriate survey instruments to each Authorized User so that an instrument is available in each laboratory in which radioactive materials, other than tritium, are used.

#### 3.15.2 Calibration

All radiation protection instruments, such as area or effluent monitors, survey meters, and pocket dosimeters, shall be calibrated at least once in each calendar year and at intervals not to exceed 15 months. They shall bear

a label indicating the latest calibration date and the name of the person or company which performed the calibration.

A meter instrument is considered to be calibrated when it reads within 10% of the correct value at two points (approximately 1/3 and 2/3 full scale) on each range to be used, or if it reads within 20% of the correct value and a calibration curve is furnished for each range to be used. The RSO provides calibration service at no charge to the user.

### 3.15.3 Repair

The RSO is responsible for maintenance and repair of all CUA-owned radiation protection instruments.

## 3.16 RESPONSIBILITIES OF AUTHORIZED USERS

The primary responsibility of Authorized Users with respect to radiological safety is to ensure that the radiation exposure of themselves, those for whose radiological safety they are responsible, and the public, is not only maintained within the limits prescribed in this manual, but as low as is reasonably achievable. To this end they shall:

- a. Be familiar with, comply with, and require compliance by others with, the instructions in this manual and their authorizations for use of sources of ionizing radiation;
- b. Plan adequately for experiments and emergencies, consulting the RSO when appropriate;
- c. Teach those for whose radiological safety they are responsible (by instruction and example) the use of safe techniques and the application of approved radiation safety practices (The RSO will conduct or assist in such instruction on request);
- d. Ensure that appropriate radiation survey and monitoring equipment is available and used, and that it is functional and calibrated when due;
- e. Ensure that appropriate protective equipment (e.g., shielding, exhaust hoods and filters, glove boxes, etc.) is available and properly used and maintained;
- f. Maintain a current working record of the receipt and disposition of radioactive material charged to them;
- g. Limit the use of sources of ionizing radiation charged to them to individuals over whom they have supervisory control and to locations specified in their User Authorizations, and ensure that no unauthorized use is made thereof;
- h. Allow only authorized persons to enter rooms specified as restricted areas;

i. Establish for each restricted area for which they are responsible a daily laboratory "Close-Down" procedure to ensure that:

(1) Survey meter measurements (except for tritium) have established that external radiation and contamination levels are within permissible limits,

(2) Radiation sources are properly labeled and stored,

(3) Experiments which will be in progress after normal working hours either will be properly attended or represent no hazard to those who have access to the spaces,

(4) The area is secured against unauthorized access,

j. Inform the RSO, in a timely manner, when:

(1) They cannot fulfill their responsibilities as Authorized Users due to expected protracted absence from the University (With the approval of the RSC, another may be appointed to serve in the Authorized User's absence),

(2) The Authorized User or a radiation worker under the Authorized User's supervision has declared she is pregnant,

(3) Changes are anticipated in the work under the Authorized User's supervision which may increase the probability or extent of exposure to ionizing radiation,

(4) Changes are anticipated in personnel working with sources of ionizing radiation,

k. Inform the RSO immediately if any of the following circumstances is known or suspected:

(1) Exposure of an individual to external radiation in excess of 50 mrem in a single exposure or 100 mrem in any one week,

(2) Inhalation, ingestion or injection of radioactive material by any person,

(3) Accidental release of radioactive material to the atmosphere, surfaces, drain or ventilation system.

### 3.17 RESPONSIBILITIES OF INDIVIDUAL USERS

#### 3.17.1 Definition

"Individual User" is defined to mean any person who works with sources of ionizing radiation under the supervision of an Authorized User.

### 3.17.2 Responsibilities

Individual Users shall conduct their operations so as to maintain the radiation exposure of themselves and others as low as is reasonably achievable. To this end they shall:

a. Understand and comply with the work habits prescribed in Section 3.18, and the instructions received from the Authorized User to whom they are responsible;

b. Wear prescribed personnel monitoring equipment and protective clothing during all work with or in the vicinity of sources of ionizing radiation;

c. Consult the Authorized User to whom they are responsible BEFORE PROCEEDING if they have any doubt about the correctness or safety of an intended procedure;

d. Inform the responsible Authorized User and/or the RSO immediately if any of the following circumstances is known or suspected:

(1) Exposure of any person to external radiation in excess of 50 mrem in a single exposure or 100 mrem in any one week;

(2) Inhalation, ingestion or injection of radioactive material by any person;

(3) Accidental release of radioactive material to the atmosphere, surfaces, drains or ventilation system of the room;

e. Keep accurate records of the use and disposal of radioactive material entrusted to them;

f. Make no unauthorized use or disposition of radioactive material.

## 3.18 WORK HABITS

### 3.18.1 Preparatory

Before any work is undertaken with radioactive material which could produce significant external or internal exposure, attention shall be given to precautionary measures, including the use and adequacy of hoods, filters, remote handling equipment, respiratory protection, etc. The RSO shall be consulted on specific operations which depart from previously authorized procedures.

FOR NON-ROUTINE OR HIGH-LEVEL OPERATIONS UTILIZING UNSEALED MATERIAL, THE USER SHALL CONDUCT TRIAL RUNS, USING STABLE ISOTOPES, OR LOW-LEVEL RADIOACTIVE MATERIAL CONCENTRATIONS, SUFFICIENT TO DEMONSTRATE THE ADEQUACY OF PROCEDURES AND EQUIPMENT.



### 3.18.2 Protective Clothing

Suitable gloves shall be worn during all work with unsealed radioactive material or when contamination is possible. Extra care shall be exercised to prevent contamination when there is a break in the skin below the wrist. Dispose of gloves to radwaste after use. Protective glasses or goggles shall be worn if there is a possibility of radioactive contamination of the eyes.

Appropriate protective clothing, such as coveralls, laboratory coats, rubber aprons, and shoe covers, shall be worn whenever contamination of clothing with radioactive material is possible. Protective clothing shall not be worn or taken out of the local areas in which its use is required unless monitored and found free of contamination. Under no conditions may protective clothing be worn in eating places.

### 3.18.3 Materials Handling

a. Prior to performing an operation on or with a source of ionizing radiation, radiation levels shall be measured. Remote handling tools, such as forceps and tongs, shall be used for handling a source which causes an exposure, at contact, in excess of 50 mrem/h.

b. When working with a source of ionizing radiation which emits penetrating radiation of sufficient intensity to produce significant exposure a survey meter shall be used to monitor work in progress to confirm the adequacy of shielding or remote handling tools.

c. When performing operations which might produce airborne contamination (e.g., evaporation, sanding or grinding, transfers of unsealed powder or volatile radioactive material, etc.), approved exhaust ventilation shall be used. When recommended by the RSO, appropriate filtration of effluent air shall be provided.

Approved exhaust ventilation means a hood, glove box, or local exhaust facility which has been approved by the RSO for work with the quantity and type of isotope to be used. Approved facilities shall be so-designated by printed labels attached to the ventilation unit by the RSO.

d. Work which can result in contamination of work surfaces shall be done in trays. The choice of tray material will depend on the chemicals to be handled and the relative merits of disposable vs. decontaminatable trays. Adjacent work surfaces shall be lined with an absorbent material having a liner which is impervious to the chemical compounds to be used. Consideration should be given to the desirability of similarly lining the tray.

e. Work areas shall be kept clean and free of equipment and materials not required for the procedures in progress.

f. Unsealed radioactive material shall be stored in shatterproof plastic containers when practicable. Glass containers used to store radioactive material shall be stored and transported within a shatterproof protective outer container.



g. All containers of radioactive material to be left unattended shall be properly labeled.

h. Contaminated equipment and tools (glassware, hotplates, stirrers, hand tools, etc.) shall be appropriately identified and isolated from other equipment if it is to be retained for future use. Once used for radio-active work, such material shall not be removed from a restricted area until demonstrated to be free of contamination in accordance with Section 3.6, unless it is packaged and removed as radwaste.

i. Apparatus shall not be washed into the sewer system if it contains any activity appreciably above background when measured with an appropriate survey meter.

j. Special care shall be exercised when assembling, disassembling and manipulating contaminated glassware in order to minimize the risk of contaminated wounds.

#### 3.18.4 Hygiene

a. MOUTH PIPETTING OF RADIOACTIVE MATERIAL IS FORBIDDEN!

Not only is the practice unacceptably dangerous, but the precision and speed of modern pipetting equipment far exceeds that obtainable by mouth.

b. Eating, preparing, or storing food or drink is forbidden in rooms where work with unsealed sources is taking place or where removable contamination exists.

c. Smoking is prohibited in all restricted areas.

d. The hands and forearms shall be washed thoroughly before handling any object which goes into the mouth, nose or eyes and on completion of work with unsealed radioactive material; a survey meter shall be used to confirm freedom from significant contamination when appropriate.

e. Personnel working in areas containing radioactive material shall "wash up" before eating, smoking, or leaving work; they shall make hand and shoe surveys, when appropriate, prior to leaving a restricted area where operations with unsealed sources are conducted.

f. Food, drink and photographic film shall not be stored in a refrigerator used for storage of radioactive material.

g. Application of cosmetics in restricted areas should be discouraged and may be prohibited if, in the opinion of the Authorized User or the RSO, prohibition is warranted in specific restricted areas.

h. Keeping fingernails short minimizes the probability of contamination and of puncturing the fingertips of protective gloves.

i. If, in the course of work with unsealed radioactive material, personal contamination is suspected, work shall be stopped (as soon as can be done without creating a greater hazard) and a survey with a suitable instrument shall be made. This shall be followed by any required decontamination and a further survey. Routine precautionary surveys shall be made at intervals.

### 3.19 USE OF RADIOACTIVE MATERIAL IN ANIMALS

a. Radioactive material shall not be used in experimental animals without the approval of the RSC. The RSO shall be advised when authorized work is commenced.

b. The use of animals for experimental purposes shall be consistent with the guidelines set forth in DHHS Publication No. (PHS) 86-23 (Revised 1985).

c. The Authorized User is primarily responsible for the care of animals during the course of an experiment and is responsible for the safe use of the radioactive material involved. The RSO is responsible for ensuring that the use of the radioactive material conforms to the regulations of the NRC and this University.

d. The Authorized User shall indoctrinate all persons who handle or work in the vicinity of radioactive animals as to the dose levels, time limitations in the area and handling requirements for the animals and their excreta.

e. Injection of radioactive material should be performed in trays lined with absorbent material.

f. All cages housing radioactive animals shall bear a radiation caution label which identifies the isotope administered, activity injected or otherwise administered per animal, date of administration, and the identity of the responsible Authorized User.

g. All cages, equipment used, and the room housing the animal(s) shall be considered contaminated until demonstrated otherwise. The RSO shall monitor the area for contamination.

h. Adequate ventilation shall be provided when animals are kept after injection with radioactive material which may become volatilized and dispersed into the room (e.g., tritium and iodine).

i. Animal excreta may be disposed of via the sewerage if the calculated activity concentration does not exceed that listed in 10 CFR 20, Appendix B, Table 3 (Appendix B of this manual), and if it is not mixed with sawdust, wood shavings or other absorbent material; otherwise the excreta shall be placed in plastic bags together with sufficient absorbent material to eliminate free liquid and disposed of as dry radwaste.

j. Dead animals shall be placed in plastic bags and kept frozen by the responsible investigator pending disposal. Arrangements shall be made by the responsible investigator with the RSO for disposal of contaminated carcasses.

### 3.20 RADIATION-PRODUCING MACHINES (RPM)

Radiation-producing machines (or equipment) are defined in Table II at the beginning of this manual.

#### 3.20.1 Exemption from Regulation

Equipment is not subject to these regulations if the production of ionizing radiation is not its primary purpose and the exposure does not exceed 0.5 mrem/h at 5 centimeters from any accessible surface.

#### 3.20.2 RSO Responsibility and Authority

The RSO shall be permitted access to radiation-producing equipment for the purpose of inspection and survey.

The RSO shall:

a. Survey each RPM at its initial testing and at subsequent intervals not to exceed one year. Annual re-survey is not required if the machine is not in use, but a survey shall be conducted at the first resumption of operation.

b. Establish safety restrictions on the use of each RPM for the protection of operating personnel and the public. (Should the principal Authorized User believe that RSO-established restrictions are too strict, a review by the RSC may be requested; the request shall be addressed, in writing, to the Chair).

c. Conduct an orientation lecture concerning the hazards and safety precautions associated with the use of each type of RPM which shall be attended by each individual who is to be authorized to operate the equipment without direct supervision.

d. Halt the use of any RPM which whose operation presents a radiation hazard.

e. Report violation of the safety restrictions, the general safety rules in Section 3.20.3, or lack of operator cooperation to the RSC.

#### 3.20.3 General Safety Rules

Radiation-producing equipment shall be operated only by designated personnel. Designated personnel are defined as "Principal Users" or "technicians". Qualifications of Principal Users shall be submitted to the RSC for approval on Form RSO-4 "Qualifications of Principal Users of Radiation-Producing Machines" (Appendix F). Qualifications of technicians shall be

evaluated and approved by a Principal User and written notification of this qualification shall be on file with the RSC and possessed by the technician. Technicians shall operate radiation-producing machines under the supervision of a Principal User. Students and others who use RPE as part of a regularly scheduled course or on a very infrequent basis are exempt from the requirement of registration with the RSC, provided that such operation is conducted under the direct supervision of a Principal User. All RPE shall be operated in accordance with the following provisions:

a. Areas in which RPE is located or is being used shall be posted with the characteristic "Caution (or Danger) Radiation" or "Caution (or Danger) X-rays" sign to warn unauthorized personnel from entering the radiation area. The controls for each RPM shall have a decal stating "Caution (or Danger) Radiation - This Machine Produces Radiation When Energized." In certain instances, other precautions, such as locking the entrances to the rooms, locking the machine controls, or the use of automatic safety devices, may be required by the RSC.

b. Radiation-producing equipment shall not be operated without the presence of the RSO if it has not been operated for more than one year.

c. A portable radiation-producing machine shall not be operated at locations outside the laboratory where the machine has been surveyed without the prior approval of the RSO.

d. Each radiation-producing machine shall be disconnected from its power source or locked to preclude operation when not in actual use.

e. The operator shall clear the primary beam and scatter exposure areas of all personnel before operating the machine and assure that all essential personnel are adequately shielded.

f. Personnel monitoring devices shall be worn by the operator and all others present during operation of any machine which is capable of creating an exposure field in excess of 25 mrem/h at any accessible location.

g. The operator shall never expose himself or others to the direct beam of the machine and must not enter an exposure or target room while a machine is in operation unless adequately shielded.

h. All incidents involving radiation levels in excess of those authorized or anticipated, or possible exposures of personnel in excess of 100 mrem, shall be reported immediately to the RSO.

i. A primary beam shall not be directed towards an interior wall, ceiling or floor in the absence of primary beam shielding.

j. All operating personnel shall observe all restrictions, established by the RSO or RSC, on the use of RPE. They shall bring to the attention of the RSO discovery of a potentially hazardous mode of operation which has not been anticipated by such restrictions.

k. The structural shielding requirements for any new installation or for an existing installation in which changes are contemplated shall be discussed with the RSO. The implementation of these requirements is subject to prior RSC approval.



## CHAPTER 4

## SPECIAL INSTRUCTIONS FOR UNIVERSITY STAFF DEPARTMENTS

## 4.1 INTRODUCTION

Radiation precaution signs and labels apply to all personnel. They do not mean that a hazard exists unless it is explicitly so-stated; they do mean that a hazard could exist if inappropriate action were taken. Most frequently these signs mean that radioactive materials are present in shielded containers. These containers, which may be of metal, glass or plastic (depending on the type of radioactive material contained), are individually labeled and should not be touched or moved by staff personnel who must perform work in a restricted area. All working areas of these rooms are checked frequently for radioactive contamination and are safe for work by cleaning, maintenance or security personnel.

## 4.2 HOUSEKEEPING

The Director of Housekeeping shall ensure that all housekeeping personnel (whether University or contractor employees) who are assigned to work in Hamman, Maloney, McCort-Ward, Nursing-Biology and Pangborn Halls know and understand the following rules which have been established for their safety:

- a. Housekeeping personnel shall not do any work inside a fume hood or glove box which bears a radiation warning sign.
- b. Housekeeping personnel shall remain outside any area within a laboratory which is roped off with a yellow and magenta radiation warning rope.

## 4.3 MAINTENANCE

The Director of Maintenance shall obtain prior clearance from the Radiation Safety Officer before permitting maintenance work to proceed on the following types of facilities.

- a. Fume hoods bearing a radiation warning sign.
- b. Ducts and blowers which service fume hoods bearing a radiation warning sign.
- c. Pits or sumps in the sewer system for Hamman, Maloney, McCort-Ward and Pangborn Halls.
- d. Any facilities in the Quonset Hut.
- e. Any other facility where there is any question as to the possible presence of radioactive contamination.



In working within restricted areas, maintenance personnel shall remain outside any area which is roped off with a yellow and magenta radiation warning rope, unless accompanied by the Authorized User who is responsible for the area, or by the Radiation Safety Officer.

#### 4.4 PUBLIC SAFETY

The Director of Public Safety shall ensure that:

- a. All newly-hired Security Officers attend an elementary radiation safety lecture as part of their initial indoctrination for employment at CUA.
- b. All Security Officers attend an annual refresher lecture on radiation safety.

(These lectures will be given by the RSO upon request by the Department of Public Safety.)

- c. Security guards who find a restricted area open and unattended shall:
  - (1) Close and lock the room, and
  - (2) Report the matter to the Dispatcher.
- d. The cognizant Department Chair and the Radiation Safety Officer are advised, on the next regular working day, of the date, time and location of the action taken under sub-paragraph (c).

#### 4.5 PURCHASING

The Director of Purchasing shall ensure that:

- a. A purchase order is not prepared (nor a purchase order number provided for a telephonic order) for any radioactive material unless the requisition bears the stamp of approval of the Radiation Safety Officer. In case of doubt, the originator of the requisition, or the Radiation Safety Officer, shall be asked if the material being ordered is radioactive.
- b. All purchase orders for radioactive material shall show the delivery address as:

The Catholic University of America  
Radiation Safety Office, Room B18A Pangborn Hall  
or if not open  
Department of Public Safety, 109 Administration Bldg.  
Washington, DC 20064

## 4.6 SPONSORED PROGRAMS AND RESEARCH SERVICES

The Assistant Academic Vice President for Sponsored Programs and Research Services shall ensure that:

Each proposal for or solicitation of support for research, which indicates that the use of radioactive material or other sources of ionizing radiation (such as X-ray or X-ray diffraction machines) is intended in the course of the proposed research, has been reviewed and endorsed by the University Radiation Safety Officer before it is released to the addressee. The endorsement of the Radiation Safety Officer is solely for University internal purposes and should not accompany the proposal when it leaves the University.

## CHAPTER 5

## EMERGENCY PROCEDURES

## 5.1 INTRODUCTION

For the purpose of this manual, an emergency is defined as any incident resulting from the use of one or more sources of ionizing radiation which creates an internal or external hazard to personnel. The primary purpose of a planned response to a radiation emergency is (a) to minimize internal contamination by radioactive material due to ingestion, inhalation, absorption or entry through wounds, (b) to hold exposure to external ionizing radiation to the lowest possible level, and (c) to provide appropriate first aid or medical care on a basis consistent with (a) and (b).

An emergency may vary in magnitude from an apparently insignificant spill of low-level radioactivity to a fire or explosion involving hazardous quantities of radioisotopes. The following steps are applicable to responding to all emergencies. Detailed suggestions for handling specific types of emergencies are given in Section 5.4; they should be modified by each Authorized User to meet the specific requirements of each restricted area for which he/she is responsible.

- a. Evaluate the situation in regard to levels of external radiation exposure and the risk of contamination by radioactive material. If a situation develops where an emergency involving radioactivity also has a potential for producing other serious hazards, e.g., flammable or toxic fume accumulations, you are urged to consider all hazard potentials and act accordingly.
- b. If external radiation levels are high, evacuate exposed personnel from the accident area, if the possibility exists that personnel are contaminated, confine their movement until they have been monitored.
- c. The quantities of radioactive materials approved for use by Authorized Users at CUA are low enough that medical attention for serious injuries should always take precedence over decontamination procedures.
- d. Obtain RSO and other appropriate assistance promptly.
- e. Monitor all persons who may be contaminated. Perform simple decontamination, if necessary, and re-monitor. Give first aid if needed.
- f. Obtain a careful history of the accident.

## 5.2 AUTHORIZED USER RESPONSIBILITY

The Authorized User is primarily responsible for preparing himself and those for whose work he is responsible to respond promptly and correctly to

those emergencies which are credible with respect to his use of ionizing radiation. Guidance is provided in this Chapter of the CUA Radiation Safety Manual. Each Authorized User shall:

- a. Prepare and maintain current an emergency plan for each restricted area for which he is responsible. A copy shall be provided to the RSO.
- b. Post the emergency plan conspicuously in each restricted area.
- c. Ensure that all personnel authorized to work in a restricted area are familiar with the emergency plan.
- d. Prepare a complete written history of each emergency and subsequent related activity, including corrective and preventive actions. This report shall be delivered to the RSO within 15 days of the emergency.

### 5.3 EMERGENCY RESPONDERS

Authorized Users of sources of ionizing radiation on the CUA campus are required (by Section 3.3) to post at the entrance to each restricted area the name and telephone number(s) of the individuals to be contacted in case of an emergency.

The CUA Radiation Safety Officer may be reached on extension 5206 and at 703-671-1659 after working hours. If neither the Authorized User nor the RSO can be reached, any technically qualified member of the Radiation Safety Committee may be called. The names and telephone numbers of the committee members are listed in Appendix A. Call Public Safety (5111) for all events requiring emergency assistance.

### 5.4 PROCEDURES FOR SPECIFIC TYPES OF EMERGENCIES

#### 5.4.1 Airborne Contamination, Radioactive dust, mist, fumes, gases, organic vapors

- a. EVACUATE all other personnel immediately.

Hold breath and, to the extent possible, close windows and turn off window air conditioning units. Turn ON all hood blowers.

Leave the room.

Close and lock the door to preclude unauthorized entry.

- b. HOLD all personnel involved immediately outside the room and instruct them to stay in one location to prevent the spread of contamination.
- c. ISOLATE the adjacent corridor against traffic and spectators.

d. NOTIFY the RSO; hold personnel for his arrival, and assist him in evaluating hazards, determining re-entry times, and monitoring for personnel contamination. (NB: If an air conditioning system serving the affected laboratory serves other rooms, evacuate those rooms until the extent of the spread of contamination can be evaluated.)

#### 5.4.2 Contaminated Personnel - Uninjured

- a. External Contamination: See Section 5.5, Decontamination.
- b. Internal Contamination: See Section 5.4.3, Contaminated Casualties.

#### 5.4.3 Contaminated Casualties

##### a. Definition

Individuals who have (or are suspected to have) become internally contaminated with radioactive material by ingestion, respiration, contact with an open wound, puncture, or contact with the eyes shall be considered to be contaminated casualties.

##### b. Supporting Emergency Plans

Radiation Emergency Plans have been prepared by the Department of Consumer and Regulatory Affairs of the Government of the District of Columbia. These plans provide for response, as appropriate, by the Fire Department (Fire and Ambulance Services), Police Department, Hospitals, and the Department of Consumer and Regulatory Affairs. The contact point for initiation of DC government assistance is the Department of Consumer and Regulatory Affairs, Pharmaceutical and Medical Device Control Division, during normal working hours, and the main DC government telephone switchboard at all other times. All hospitals in the District of Columbia except The George Washington University Hospital and Sibley Memorial Hospital are prepared to receive and treat contaminated casualties. Because of its facilities and proximity to the University, the Washington Hospital Center, located at 110 Irving Street, NW (approximately one mile west of the campus), is the hospital of choice for contaminated casualties originating on campus. The Walter Reed Army Medical Center, located at 6825 Sixteenth Street, NW (565-3501), is prepared to provide emergency treatment of contaminated casualties if, for any reason, civilian hospitals in the District of Columbia are unable to provide service.

##### c. Emergency Action

- (1) DIAL 727-7721 (8:15 AM to 4:30 PM, Monday through Friday).

This places you in direct contact with the Pharmaceutical and Medical Device Control Division of the Department of Consumer and Regulatory Affairs of the District of Columbia.

- or 727-1000 (At all other times) (Main DC government switchboard)



## (2) REPORT, "I have a radiation emergency"

State the nature of the emergency, the number of contaminated casualties, their exact location, and the general nature of the injuries.

Ask for Ambulance, Fire Equipment, Police, as appropriate.

Tell the person answering the call to alert the emergency room at the WASHINGTON HOSPITAL CENTER.

- (3) NOTIFY the University Director of Radiation Safety (Office, ext 5206, or Home, 703-671-1659).
- (4) STANDBY to assist emergency response personnel as required. Post someone outside the building to direct emergency personnel to the scene.
- (5) PREVENT RADIOACTIVE CONTAMINATION SPREAD. Keep bystanders away so that a radioactive spill is not spread unnecessarily. Unless prevented by fire, fumes, etc., keep a casualty in one place to await arrival of emergency personnel.
- (6) FIRST AID measures should be used in the same manner as for a similar uncontaminated casualty. If the condition of the casualty permits, contaminated clothing should be removed and contaminated skin washed with water and soap or mild detergent. But if clothing change and washing pose any risk of increasing the severity of injuries, don't do it. The quantities of radioactive material in use at the University are insufficient to pose a significant threat to the casualty from external contamination during the period from initial injury to treatment and decontamination at the hospital.

d. Minor Wounds Which May Be Contaminated

Minor cuts, abrasions, punctures, burns, etc., which may be contaminated do not necessarily require activating the DC Government Radiation Emergency Plan. If a casualty can be transported to the Washington Hospital Center without risk of contaminating a personal or Campus Security vehicle, the following procedure may be preferable:

- (1) CALL Washington Hospital Center Emergency Room (877-6701). Tell them the nature of the casualty and the contaminant and that the casualty will be brought to the Emergency Room.
- (2) CALL the University Director of Radiation Safety (Office ext. 5206 or Home 703-671-1659).



- (3) REMOVE contaminated clothing from the casualty. Replace it with a lab coat or other available garment. Cover contaminated shoes with plastic.
- (4) WASH contaminated skin with water and soap or mild detergent.
- (5) WRAP contaminated skin areas with plastic, paper or cloth to minimize the likelihood of contamination of other clothing, skin and vehicle.
- (6) TAKE the casualty to the Washington Hospital Center Emergency Room, 110 Irving Street, NE, for wound decontamination and dressing. Public Safety (ext. 5111) will provide transportation on request.

e. Minor Wounds Not Requiring Medical Attention

If the concentration of radioactive material in the contaminating solution is known to be less than the maximum permissible concentration for unrestricted release (Appendix B, Table 2 of 10 CFR 20 - Appendix B to this manual), the decision to seek medical attention can be made solely on the basis of the nature of the physical injury. If medical attention is not required, the following procedure will provide adequate decontamination:

- (1) Encourage bleeding to flush the wound, while irrigating with copious quantities of water.
- (2) Use the decontamination procedures of Section 5.5.

5.4.4 Explosion

Proper response to an explosion involving radioactive material consists of appropriate responses to the physical and radiological health hazards which accompany the explosion:

- a. Airborne Contamination: See Section 5.4.1
- b. Contaminated Personnel: See Section 5.4.2
- c. Contaminated Casualties: See Section 5.4.3
- d. Fire: See Section 5.4.5

5.4.5 Fire

- a. Call Fire Department - (Dial 9-911)

Tell them radioactivity is involved. It is far better to have them and not need them than vice versa.

t. Activate the Building Fire Alarm

Use judgement. Most laboratory fires pose no threat to the rest of the building, but if there is a threat of spread of significant quantities of radioactive material, the building alarm should be used. Any available personnel not needed on the scene should be used to pass the word so that the building is actually evacuated. Have someone call Public Safety so that personnel can be kept out of the building until the situation is brought under control and for assistance in directing Fire Department responders to the scene.

c. Use Fire Extinguisher

CO<sub>2</sub> is safe on any type of laboratory fire except burning metal, for which sand is recommended. Use water or chemical extinguisher only on paper. Stay and fight the fire until the Fire Department arrives, unless threatened by fumes or radioactivity release.

d. Pull the Plug

If electrical or electronic equipment is smoking or burning, the fault which caused the trouble could have by-passed switches and fuses. Most such fires go out when the plug is pulled. If fire threatens to spread, turn off all other electrical equipment (including window air conditioners) except hood blowers before leaving.

e. When to Get Out

If fire seriously threatens radioactive material storage areas or is likely to generate airborne radioactivity from an experiment in progress - GET OUT. If smoke or non-radioactive fumes interfere with breathing, get out.

f. Notify the RSO and the Department Chair

Call both of them (at home, if after hours) as soon as the situation permits.

g. Stand By

Make a note of the events, people present, etc., while it is fresh in your mind. If there is any possibility that anyone is contaminated by radioactive material, hold them in the vicinity if possible until they have been checked by the RSO, or at least by a survey meter.

5.4.6 External Radiation Exposure

The only source of ionizing radiation on the CUA campus which is of sufficient intensity that emergency response to external exposure could be required is the cesium-137 irradiation unit, located in Room 40 Hannan Hall. The cesium-137 irradiator is capable of hazardous exposures only in the event of an unauthorized attempt to disassemble the unit. Because of its location in a restricted area, and welded construction, this is considered exceedingly

unlikely. Therefore no detailed plan for dealing with external radiation exposures is provided. The following guidelines are valid for any such incident:

- a. Evacuate the victim from the radiation field to a non-radiation area.
- b. Treat the victim for shock - keep him horizontal and warm.
- c. Use the Contaminated Casualty Plan, Section 5.4.3, to call for assistance.

#### 5.4.7 Radioactive Spills

When liquid- or powder-form radioactive materials are spilled, the primary considerations are to (1) prevent the spread of the contamination, (2) prevent additional persons or objects from being contaminated, and (3) minimize the evaporation or suspension of the material into the room air.

##### a. Minor Spills

- (1) NOTIFY persons in the area
- (2) PREVENT SPREAD
  - o Cover liquid spills with absorbent paper.
  - o Dampen dry spills thoroughly, taking care not to spread the contamination. Use water unless chemical reaction with water could generate airborne contamination, in which case oil should be used. Cover dampened spill with absorbent paper.
  - o Exclude unnecessary personnel from the spill area.
  - o Mark off spill area with chalk, marker pen or grease pencil; rope it off and post warning signs to create a personnel barrier.
  - o Hold potentially contaminated personnel in a nearby area until skin, clothing and footwear can be surveyed.
  - o Remove contaminated clothing before moving personnel to a clean area. Preserve it for RSO evaluation.
- (3) CLEAN UP

Use disposable gloves (and remote handling tongs (if appropriate)). Fold and insert absorbent paper into a plastic bag and discard in the radwaste container, together with other contaminated materials, such as disposable gloves. Follow RSO guidance with respect to further decontamination requirements.

NB: Except in cases of incapacitation, the primary responsibility for cleanup and decontamination rests with the person(s) responsible for the spill. The RSO's responsibility is to provide guidance and instruction so that it is done safely and adequately.

(4) SURVEY

With a GM survey meter (other techniques may be required for tritium and some other isotopes), check the area around the spill, plus the hands, clothing and footwear of all potentially contaminated personnel.

(5) NOTIFY the RSO as soon as possible. Permit no one to resume normal work in the area until RSO approval is obtained.

b. Major Spills

A major spill is defined as a spill which entails a risk of airborne contamination in excess of the maximum permissible concentration in restricted areas (10 CFR 20, Appendix B, Table I - Appendix B to this manual), or external radiation exposure rates in excess of 50 mrem/h at 30 centimeters.

(1) CLEAR THE AREA

Notify all persons not required for response to the spill to vacate the room.

(2) PREVENT SPREAD

- ◊ Cover a liquid spill with absorbent paper, pads, or vermiculite, but do not attempt to clean it up.
- ◊ Dampen a dry spill with water (oil if chemical reaction with water could generate airborne contamination), then cover the spill as above.
- ◊ Confine the movement of potentially contaminated personnel until survey indicates they are uncontaminated.
- ◊ DO NOT attempt to clean up unless properly trained or proceeding under RSO guidance.

(3) REDUCE EXPOSURE

- ◊ If spill is on the skin, flush thoroughly with water and follow decontamination procedures in Section 5.5.
- ◊ If spill is on clothing, discard outer clothing at once. Preserve it for evaluation by the RSO.
- ◊ Shield the source, if penetrating radiation is involved AND if it can be done without further contamination or significantly increasing your radiation exposure.

- o Switch OFF window air conditioners; leave hood blowers ON.

If the room is served by an air conditioning system which also serves other rooms, evacuate all rooms served until they can be surveyed.

(4) CLOSE THE ROOM

Leave the room and lock the doors to prevent entry.

(5) CALL FOR HELP

Notify the RSO as soon as possible. Permit no one to enter until RSO approval has been obtained.

## 5.5 DECONTAMINATION PROCEDURES

### 5.5.1 General Principles of Decontamination

Successful decontamination calls for planned action. A spur-of-the-moment action or attempt at decontamination can cause more harm than good. The person responsible for the spill in a contamination accident will usually take the first steps in bringing the situation under control. Those persons responsible for a spill shall, unless physically unable, be responsible for all decontamination of the area, under the supervision of the RSO. The first consideration shall be personnel safety; persons not involved in the emergency response shall leave the area. Subsequent considerations should involve the following procedures:

a. Prevent the spread of contamination by shutting off ventilation fans, applying absorbent material in the case of liquids (applying appropriate liquid and then absorbent material in the case of dry spills), and roping off, barricading or locking the area.

b. Immediately notify your supervisor and the RSO.

c. Allow no one who has been in the spill area to leave a nearby holding area until the person has been checked for contamination.

d. Make full use of monitoring instruments and available assistance. Each step of the decontamination should be monitored. One person should remain uncontaminated to operate instruments and do other monitoring. When the instruments become contaminated, further progress is impaired. Protective clothing, footwear, gloves, and respiratory equipment shall be used as needed.

### 5.5.2 General Procedures for Personnel Decontamination

Ordinarily, the same procedures used for personal cleanliness will suffice to remove radioactive contaminants from the skin, but the specific method will depend upon the form (grease, oil, etc.) of the deposited contamination. Soap and water (sequestering agents and detergents) normally remove more than 99%

of the contaminants. If it is necessary to remove the remainder, chemicals can be used on the outer layers of skin upon which the contamination has been deposited. Because of the risk of injury to the skin surface, these chemicals (citric acid, potassium permanganate, sodium bisulfite, etc.) should be applied with caution, preferably under medical supervision. Types of lanolin-based creams are used to offset local irritation of skin surfaces after decontamination. Contaminants should be removed to the maximum feasible extent at the site of the incident.

Remove any clothing or equipment found to be contaminated before determining the level of skin contamination.

Decontaminate any areas of the body found to be significantly more contaminated than surrounding areas. This spot cleaning is necessary to reduce the spread of contamination to clean areas of the body which might otherwise occur during showering. Open wounds should be sealed or covered during this spot cleaning to prevent additional contamination from being washed into wounds.

If the contamination is general over large portions of the body surfaces, a very thorough shower is necessary. Special attention must be paid to such areas as the hair, hands and fingernails. After showering and monitoring, the residual contamination can be removed by spot cleaning.

Avoid the prolonged use of any one method of decontamination. Repeated ineffective decontamination methods may irritate the skin and thus hamper the success of more suitable procedures. No one chemical treatment is known to be specific for all of the elements with which one may become contaminated.

Avoid the use of organic solvents. Organic solvents may increase the probability of the radioactive materials penetrating through the pores of the skin. Oxalic acid is a poisonous compound and is not to be used under any circumstances.

### 5.5.3 Hand Decontamination

Numerous excellent products are commercially available for general purpose decontamination. If one or more of these is available it can be used safely to remove hand contamination. In most instances nothing more will be required. An incomplete list of such products would include the trade names Lift Away, Micro, Rad-Con, and Radiac Wash. If none of these is available, or if their use is unsuccessful, one or more of the following techniques can be tried.

Wash the skin thoroughly with an abrasive hand soap (such as Lava) and water, paying special attention to areas between the fingers and around the fingernails. Repeat the procedure if monitoring indicates that there has been improvement but that there is contamination remaining on the skin in amounts above tolerance.

Apply a sequestrant-detergent liquid mixture (a 5% water solution of a mixture of 30% Tide, 65% Calgon, and 5% Carbose). Repeat the procedure if results prove encouraging.



Apply a sequestrant-detergent cream (a 4% Carbose, 1% Versene, 8% Tide, and 85% water mixture). Rub thoroughly into the skin for approximately one minute. Repeat the treatment as long as the results show that the contaminant is being removed.

Another method is to place the contaminated hand(s) in surgical gloves with the cuffs taped tightly to the wrist. The resultant perspiration after an hour or two of wear will usually wash the contamination from the pores of the skin. CAUTION: When removing gloves, be sure that they are turned inside out; i.e., pull them off from the cuffs and not the fingertips. Discard the gloves to radwaste and wash hands thoroughly.

#### 5.5.4 Area Decontamination

When an area becomes contaminated, preparation for decontamination should be started promptly. This not only minimizes the likelihood of spread, but usually makes the job easier.

- a. Cover clean areas in the vicinity with absorbent paper.
- b. Control the flow of contaminated liquids: Apply absorbers, raise barriers (putty, etc.), seal cracks in floors, bench tops, etc.
- c. Remember that all clothing, shoes, caps, bags and brushes used are contaminated until demonstrated otherwise.
- d. Notify the RSO, who will assist in determining the extent of and the hazard associated with the contamination.

#### 2. Decontamination Methods

- (1) Solutions of detergents, EDTA, Radiacwash, etc., may be used to decontaminate many smooth, non-porous surfaces.
- (2) Metals - Low-value metallic objects should be discarded to radwaste. Oily surface films may have to be removed before decontamination measures are effective. Various commercial degreasers and organic solvents may be considered, depending on the nature of the film to be removed. High normality acids, concentrated acids, or aqua regia may be used if needed and if the surfaces will withstand such treatment.
- (3) Concrete or brick - Solutions of HCl, used with commercial scrubbers. Probably will not be completely successful.
- (4) Glassware - Appropriate solvents or detergents, or discard to radwaste.
- (5) Linoleum, asphalt tile, vinyl tile, etc. - if well waxed before contamination, removal of wax with solvents or scouring powder and steel wool may decontaminate. Or the floor covering can be replaced. In some cases, a radio-

active liquid will have penetrated, via cracks and joints in a floor covering, to the main floor surface. It will then be necessary to remove the floor covering in the affected area and decontaminate the main floor surface.

- (6) Wood - Sand (with careful attention to dust control), plane, or discard to radwaste.
- (7) Painted surfaces - Paint removers.

f. Decontamination Standard

An area is considered free from radioactive contamination when a wipe test shows removable contamination to be less than 1000 dpm/100 cm<sup>2</sup> of beta-gamma emitters and less than 100 dpm/100 cm<sup>2</sup> of alpha emitters. Higher limits may be tolerable in some restricted areas (See Section 3.8.4); lower limits should be applied if decontamination can be accomplished with reasonable effort.

## INDEX TO APPENDICES

APPENDIX	TITLE
A	Radiation Safety Committee Membership
B	"Standards for Protection Against Radiation," 10 CFR 20
C	"Instructions Concerning Prenatal Radiation Exposure," US NRC Regulatory Guide 8.13
D	Disposal of Radioactive Waste and Surplus Radioactive Sources
E	Publications Available to Radiation Workers
F	Radiation Safety Office Forms
G	Instructions for Completing the Application for User Authorization (Form RSO-2) Radioactive Material)

## APPENDIX A

## RADIATION SAFETY COMMITTEE MEMBERSHIP

January 1992

<u>NAME</u>	<u>TITLE</u>	<u>ADDRESS</u>	<u>TEL</u>
Dr. Gregory Brewer <sup>2</sup>	Asst. Prof. Chemistry	102H MAL	5396
Mr. Robert Fawbush	Mgr. Elect/Mechan Services	201 POWR	5122
Mr. Clay Goldston	Dir. Public Safety	109 ADMIN	5111
Dr. Warren Keepe <sup>2</sup>	Rad. Safety Officer	B15A PANG	5206
Dr. Scott Keimig	Dir. Environmental Safety	7 ADMIN	6112
Dr. Isabelle Muller <sup>2</sup>	Research Associate	310 HAN	5331
Dr. Roland Nardone <sup>2,1</sup>	Dir. Contr-Advanced Training	301 MCW	5275
Dr. Daniel Sober <sup>2</sup>	Prof. Physics	209 HAN	5856
Dr. Jean Toth	Assoc. Prof. Nursing	206 GOW	5110

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<sup>2</sup> Technically qualified to assist in the radiation aspects of an emergency.

1. Chair, Radiation Safety Committee

APPENDIX B

STANDARDS FOR PROTECTION AGAINST RADIATION

Appendix B consists of Title 10, Code of Federal Regulations, Part 20 (10CFR 20), entitled "Standards for Protection Against Radiation," as amended from time to time. A copy of the current version is distributed with this manual for reference.

APPENDIX C

INSTRUCTIONS CONCERNING PRENATAL RADIATION EXPOSURE

Appendix C consists of US NRC Regulatory Guide 8.13, entitled "Instructions Concerning Prenatal Radiation Exposure," as revised from time to time. A copy of the current version is distributed with this manual for reference.



## APPENDIX D

## DISPOSAL OF RADIOACTIVE WASTE &amp; SURPLUS RADIOACTIVE SOURCES

## D-1 DEFINITION

Radioactive waste (radwaste) is defined to mean:

a. Unsealed radioactive material, of whatever chemical or physical form, whose retention is no longer desired by the responsible Authorized User,

b. Material or equipment which is, or is presumed to be contaminated because of its use in association with radioactive material (e.g., disposable gloves and other protective clothing, glassware, tray and bench covers, tools, etc.),

c. Sources of radioactive material which have been determined by the RSO to be:

- (1) Leaking beyond allowable limits and not economically repairable,
- (2) Reduced below useful activity by radioactive decay, or
- (3) Surplus to the needs of the University and of individual replacement value less than \$500.00.

## D-2 INTRODUCTION

This Appendix provides detailed instructions for the handling of all radwaste which is generated on the CUA campus, from its initial generation in the laboratories of Authorized Users until it is lawfully removed from the campus. Radwaste shall be disposed of only in accordance with the provisions of this Appendix. Specifically radwaste shall NOT be:

- a. Incinerated on the CUA campus,
- b. Buried on the CUA campus,
- c. Deposited in ordinary trash containers, or
- d. Transported off campus except by duly licensed persons,
- e. Discharged to the sewer via laboratory sinks.

## D-3 DISPOSAL TO THE SEWER

D-3.1 Authority for Discharge to Seweragea. RSO Authority.

The RSO is authorized to release radioactive waste to the sewer in accordance with applicable regulations. Authorized Users shall not release radioactive material to the sewer except that incidental to routine cleaning of laboratory ware.

b. Record Keeping.

The RSO shall maintain a log in which is recorded all radioactive waste releases to the sewer. The record shall include the date, isotope and activity with respect to each release.

## D-4 RELEASE TO VENTILATION EXHAUST SYSTEMS

D-4.1 Release Control

All operations in which significant atmospheric radioactive contamination could be produced shall be performed using local air filtration, a glove box, a fume hood, or combination thereof as set forth in the User Authorization.

D-4.2 Releases to Recirculating Air Systems

Unless otherwise authorized by the RSC, the 1-hour averaged concentration of radioactive material entering an exhaust duct of a recirculating air system shall not exceed the limits of 10 CFR 20, Appendix B, Table II, Column 1.

D-4.3 Releases to Outdoor Air

In the case of a duct exhausting directly (unfiltered) to the outdoor atmosphere (e.g., fume hood or glove box exhaust), the RSO shall be notified immediately if there is a release of airborne radioactive material in concentrations which, if averaged over a period of 24 hours would exceed the limits specified for the material in 10 CFR 20, Appendix B, Table II, Column 1.

D-4.4 Permissible Averaging Time

Determinations of the average concentration of radioactive material may be made with respect to the point where the material leaves the exhaust duct. Concentrations may not be averaged over a period longer than 24 hours without prior authorization of the RSC.

## D-5 SPECIFIC DISPOSAL INSTRUCTIONS FOR RADWASTE

All radwaste shall be segregated into special collection containers in accordance with the rules contained in this Section.

D-5.1 Definitions

For waste management purposes, radwaste is categorized by class and isotope. Five classes are used: Animal, Aqueous, Dry, LSC, and Organic.

a. ANIMAL: Animal carcasses which are contaminated with radioactive material.

b. AQUEOUS: Radwaste whose primary solvent is water. It may contain dissolved or suspended organic matter.

c. DRY: Radwaste, except used liquid scintillation vials, which contains no free liquid, either because the material is "dry" in the conventional sense of the word or because cement or other approved material has been added to absorb small quantities of free liquid which may be present.

d. LSC: Liquid scintillation cocktail which contains radioactive material.

e. ORGANIC: Radwaste whose solvent(s) consist solely of organic liquid(s). It may contain dissolved or suspended inorganic matter. It may not include scintillation cocktail, whether radioactive or not.

D-5.2 General RulesD-5.2.1 Segregation

The Authorized User is responsible for segregation of radwaste by Class, and within class, by isotope. LSC waste shall also be segregated by the commercial name of the cocktail it contains.

D-5.2.2 Radwaste Containers

a. Containers for the temporary accumulation of radwaste in individual restricted areas shall be:

- o Distinctively different from trash containers used for non-radioactive trash;
- o Conspicuously marked on opposite sides with the radiation symbol (10 CFR 20.203), together with the words "Caution" (or "Danger"), "Radioactive Material";  
(continued)

- o Conspicuously labeled to indicate the class of radwaste and the isotope which is contained;
- o Lead-lined or shielded, if required in order to satisfy Section D-5.2.3.

#### D-5.2.3 Exposure Limitation

The total amount of radwaste placed in any container shall be controlled so that the radiation exposure at one foot from the container is less than 10 mrem/h and the exposure at contact with any surface of the container is less than 50 mrem/h.

#### D-5.2.4 Precautions Against Chemical Reaction

Material shall not be put into a radwaste collection container if there is any possibility of a chemical reaction during storage which might cause fire or explosion, or cause the release of chemically toxic or radioactive gases. Solutions shall be adjusted to pH 6-8 prior to disposal into a liquid container.

#### D-5.2.5 Animal Carcasses

Small animal carcasses containing administered radionuclides shall be placed in sealed plastic bags, tagged with the date, animal type, the isotope name and the total activity in millicuries. The carcasses shall then be stored in an appropriately labeled freezer until the isotope decays to background levels or arrangements have been made with the RSO for disposal by a licensed commercial firm.

#### D-5.2.6 Labeling

Each container of radwaste shall bear a radioactive label on which is entered the date packaged, the Authorized User's name, waste class, isotope name, and total activity. The label on LSC waste shall also include the commercial name of the cocktail. LSC waste whose only radioactivity is due to H-3 or C-14 shall also be labeled to indicate whether the activity concentration is LOW (less than 50 nanocurie/gram) or HIGH (greater than 50 nanocurie/gram).

#### D-5.2.7 Removal

Radwaste which is properly packaged and labeled will be picked up from individual laboratories by the RSO and transported to the CUA radwaste storage and handling facility for interim management and ultimate shipment to a licensed low level waste site.

#### D-5.2.8 Storage

The RSO is authorized to store radwaste in the CUA radwaste storage and handling facility, for the purpose of accumulating shipments of

economical size for transport to a licensed low level waste site. In the event that access to a low level waste site is denied, the RSO is authorized to store radwaste in the designated CUA radwaste storage and handling facility until site access is restored.

## D-6 DISPOSAL OF SURPLUS RADIOACTIVE SOURCES

### D-6.1 Sources Surplus to the Needs of an Authorized User

A radioactive source, other than consumable radioactive material, which is surplus to the needs of an authorized User, may be:

- a. Transferred to another Authorized User in accordance with Section 2.10.2, or
- b. Transferred to the RSO.

### D-6.2 Sources Surplus to the Needs of the University

The RSO may take the following action with respect to a radioactive source, other than consumable radioactive material, which is transferred to the RSO, as surplus, by an authorized User:

- a. Transfer the source to another Authorized User who has a need and an Authorization for it.
- b. Retain the source for the University.
- c. Transfer the source to another licensee, with the approval of the RSC.
- d. Dispose of the source in accordance with applicable regulations, and/or loan agreements (in the case of sources not owned by CUA).

## APPENDIX E

## PUBLICATIONS AVAILABLE TO RADIATION WORKERS

Appendix E consists of three sections. Section 1 lists those documents, required by 10 CFR 19 to be made available to radiation workers. Section 2 is a partial listing of additional documents which are available for reference by interested persons at CUA, and Section 3 consists of Title 10, Code of Federal regulations, Part 19 (10 CFR 19), entitled "Notices, Instructions and Reports to Workers, Inspections, as amended. (The current version is distributed to users with this manual.)

## E-1. DOCUMENTS REQUIRED TO BE AVAILABLE

The below-listed documents, required by 10 CFR 19.11 to be made available to radiation workers are available for inspection in the CUA Radiation Safety Office, located in Room B-18A Pangborn Hall:

- a. 10 CFR 19
- b. 10 CFR 20
- c. CUA Source Material License No. 08-02075-03
- d. CUA Irradiator License No. 08-02075-04
- e. CUA Source Material License No. SUD-157
- f. CUA Special Nuclear Material License No. SNM-164
- g. CUA RSC Authorizations for Possession and Use of Radioactive Material

## E-2. ADDITIONAL DOCUMENTS HELD BY THE RSO

Additional documents, which are available for review in the CUA Radiation Safety Office and which may be useful in planning for the experimental use of ionizing radiation, include:

- a. USNRC Regulatory Guides
- b. Reports of the International Commission on Radiological Protection
- c. Reports of the International Commission on Radiation Units and Measurements
- d. Reports of the National Council on Radiation Protection and Measurements
- e. DHHS (PHS) 86-23, Guide for the Care and Use of Laboratory Animals
- f. ORNL NSIC-65, Filter Handbook
- g. HASL-300, EMI Procedures Manual
- h. Selected publications of the International Atomic Energy Agency
- i. Numerous other publications of radiological health interest



## APPENDIX F

## RADIATION SAFETY OFFICE FORMS

<u>FORM #</u>	<u>TITLE</u>
RSO-1	Radioactive Material Inventory Control
RSO-2	Application to Possess and Use Radioactive Material
RSO-3	Inventory of Sealed and Plated Radioactive Sources
RSO-4	Qualifications of Principal Users of Radiation-Producing Machines
RSO-5	Qualifications of Individual Radionuclide Users
NRC-3	Notice to Employees



## APPENDIX G

INSTRUCTIONS FOR COMPLETING THE APPLICATION FOR  
USER AUTHORIZATION (Form RSO-2)

The following instructions are keyed to the entry numbers on the form:

1a. The principal investigator is the person who will be responsible for the safe storage and use of radioactive material by himself or others. When the application is approved by the RSC, the principal investigator becomes the "Authorized User" referred to throughout the Radiation Safety Manual.

1b. Users are persons who will work with the material with or without the direct supervision of the Authorized User. If the material is to be used by students in a directly supervised and regularly scheduled laboratory course, so indicate; such students need not be named in the application.

1c. Potentially exposed personnel shall include at least all persons authorized to work in the same room with the material. In the case of penetrating radiation (X-rays, gamma rays and neutrons), indicate contiguous rooms (including those above and below) or areas which could be affected by unshielded sources, if authority for sources in excess of one millicurie is requested.

2. Indicate the building and room number(s).

3a. Each isotope shall be identified by the name or symbol of the chemical element and the mass number of the isotope (e.g., cesium-137 or Cs-137).

3b. The activities listed shall be the maximum quantity desired to be on hand at any one time, including that temporarily stored as radwaste, and the maximum amount to be authorized for use in any one experiment or procedure. The quantity shall be expressed in curies.

3c. The "form" is the chemical or physical state of the material as it will be received from the supplier. If more than one form of an isotope is desired, the application must list the quantities for each form in curies.

5. Describe the purpose of the use of radioactive material in sufficient detail that the nature of the experiment or procedure can be readily understood. The information provided in sections 5 & 6 shall be sufficient to identify those procedures which entail a risk of airborne suspension of volatile or powdered radioactive materials and the anticipated maximum temperature to which each different form of the radioactive material is intended to be subjected. Identify potential accident scenarios which could result in unplanned exposure to ionizing radiation or ingestion of radioactive material by users or the general public.

6. Prepare this section so that a complete evaluation of the radiation hazards can be made; include all anticipated changes in the chemical or physical form of each isotope listed in section 3 of the form.

8. All pertinent training and experience with radioactivity or related fields must be submitted on first application from an investigator. Subsequent applications may refer to prior applications and need only list changes.

a. List school or industrial or government facility where trained.

b. Duration of training in weeks, semester hours, etc.

c. Indicate by check mark whether training was acquired on job or in formal courses.

d. If this is the first application from the investigator, list all radioactive isotopes with which experienced (on subsequent applications list at least those isotopes for which authorization is requested), the maximum amount (in curies) used at one time, and briefly indicate the nature of the use. If a supplemental page is used, so indicate and append.

9. Describe the instruments to be used for radiation exposure control and for experimentation. In the case of standard commercial instruments, list the manufacturer's name, the model number and descriptive name of the instrument and the year of manufacture or the approximate age of the instrument.

10. The application must be signed by the applicant and the immediate administrative superior (Department Chairman, Laboratory Director or Dean). The signature of the superior is necessary to indicate administrative, if not technical, knowledge of the authorization sought.