

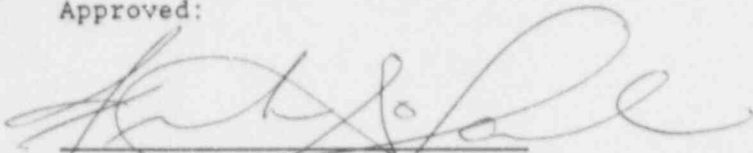
EniChem Americas, Inc.

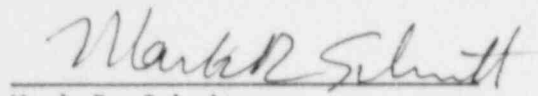
Radiation Safety Guide

First Edition

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Approved:


Frank Paul
Site Manager
EniChem Americas Princeton Research Laboratory


Mark R. Schmitt
Radiation Safety Officer
EniChem Americas Princeton Research Laboratory

30 JUL 1987

EMERGENCY PROCEDURES FOR RADIOISOTOPE LABORATORIES

IN CASE OF FIRE:

1. EVACUATE THE AREA.
2. CALL THE FIRE DEPARTMENT IMMEDIATELY.
3. CALL THE RADIATION SAFETY OFFICER.
4. USE THE PROPER FIRE EXTINGUISHER TO PUT OUT SMALL FIRES.
5. FIGHT FIRE WHILE SEEKING TO MINIMIZE POSSIBILITY OF SPREADING CONTAMINATION.
6. DECONTAMINATE IF NECESSARY AFTER FIRE HAS BEEN EXTINGUISHED.

IN CASE OF INJURY:

1. GIVE NECESSARY MEDICAL AID IMMEDIATELY, WHILE TRYING TO MINIMIZE THE SPREAD OF ANY POSSIBLE CONTAMINATION.
2. IF REQUIRED, CALL FOR MEDICAL ASSISTANCE AT ONCE.
3. CALL THE RADIATION SAFETY OFFICER.

EMERGENCY PHONE NUMBERS:

FIRE DEPARTMENT: (201) 329-4646

MEDICAL AID: (201) 329-4646

RADIATION SAFETY OFFICER, Mark R. Schmitt
WORK: (201) 422-0400
HOME: (609) 394-3661

IF RADIATION SAFETY OFFICER UNAVAILABLE CALL SAFETY
COORDINATOR, John P. Sinisi
WORK: (201) 422-0400
HOME: (201) 563-1767

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INTRODUCTION

All uses of radioactive material at the EniChem Americas Research Laboratories (EniChem) are controlled by the radiation protection program.

NO WORK WITH SOURCES OF IONIZING RADIATION
CAN BE INITIATED UNLESS PRIOR AUTHORIZATION HAS
BEEN OBTAINED FROM THE RADIATION SAFETY OFFICER.

All uses of ionizing radiation (except ultraviolet radiation) in New Jersey are controlled and regulated by either the U.S. Nuclear Regulatory Commission (NRC) or the State of New Jersey Department of Environmental Protection Bureau of Radiation Protection (DEP). EniChem has received a license from the NRC to use limited amounts of radioactive material in biological research. We have established a radiation safety program to give the necessary assurances to the NRC as well as to the company management that all potentially hazardous sources of radiation will be used safely.

This guide describes the organization of the program and specifies the regulations, policies, procedures and practices which are to be followed in using radiation sources at EniChem. The guide was presented to the NRC as describing the EniChem radiation safety program. It was accepted as such as so referenced in the license subsequently issued. Consequently, the guide is a legal document governing all uses of radiation at the EniChem Research Facility.

It is EniChem's policy to encourage the use of radiation where appropriate, but always with the insistence that there be no unwarranted radiation exposure; thus, due regard must always be given to the safety and welfare of the radiation workers and the general population as well as to the protection of EniChem property and liability. The EniChem operational policy places ultimate responsibility of the person who is supervising the use of radiation sources (Supervisors). These persons can satisfy their responsibilities by adhering to this guide and by requesting assistance from the Radiation Safety Officer (RSO) when there are questions or suspected problems.

This guide is organized in the following manner:

Section 1. General Description of the EniChem
Radiation Safety Program, Organization and
Responsibilities.

Section 2. Detailed Procedures and Practices.

DESCRIPTION OF RADIATION SAFETY PROGRAM

There are four levels of radiation safety responsibility in the EniChem Radiation Safety Program:

A. The Radiation Safety Officer (RSO). The RSO together with the EniChem Radiation Safety Committee (RSC) establishes the radiation safety policy such that:

1. Unwarranted radiation safety exposures of EniChem employees and the general public are avoided.
2. Compliance with all federal, state, and local regulations is assured.
3. EniChem property and liability are protected.

Specifically, the RSO meets his responsibilities by routinely monitoring all uses of radioactive material to ensure that a) each use is by or under the supervision of a properly authorized supervisor; b) that the appropriate personnel and environmental monitoring equipment is being used; and c) that radioactive material is properly secured against unauthorized removal when not in use.

B. The Radiation Safety Committee. The EniChem Radiation Safety Committee shall consist of a Research, Principal or Senior Scientist (who shall Chair the committee), a Research Associate or Senior Research Associate, and a Research Assistant, all of whom have practical experience in laboratory use of radioisotopes. Additional members shall include a representative of Laboratory Management and the Site Safety and Environmental Coordinator.

The RSC is responsible with the RSO for setting the Radiation Safety Policy of the Laboratory and for approving applications for Supervised User status. In addition, the Committee will review the records of occupational exposure of radiation workers at the laboratory on a quarterly basis.

C. The Supervisor. The supervisor is a person permitted by the RSO and the NRC to use radiation sources. He has primary responsibility for the radiation safety associated with each source under his control. He must verify that each person under his supervision using these sources is properly trained and aware of the attendant hazards (see training requirements). He must also supervise the use of the sources to ensure conformation to all the safety conditions of his authorization and those of this guide.

D. The Supervised User. These individuals must use the sources of radiation only under the direction of a supervisor. They must follow those procedures and practices established by the RSO and RSC. All users are required to attend a Radiation Safety Orientation lecture before they begin work with radioactive materials (see training requirements).

RADIATION REGULATIONS, POLICIES, PROCEDURES AND PRACTICES

Federal Regulations.

The Nuclear Regulatory Commission has established "Standards for Radiation Protection" 10 CFR 20 (see Apperdix for a copy). These standards must be strictly adhered to during all uses of by-product (radioactive) material. The NRC also has adopted regulations which assure that workers will be advised of the sources of radiation being used, the hazards, the safety precautions in effect, etc. at the place of employment. These rights are presented in "Notice of Instructions and Reports to Workers; Inspections" 10 CFR 19 (see Appendix for a copy).

EniChem Policies and Procedures.

The management of EniChem recognizes both the NRC regulations and company policy of preventing unnecessary exposures to radiation as the basic criteria for establishing the radiation safety policies and procedures. The principle means by which the company assures the safe use of sources of radiation are:

1. To require that a person be authorized to use or supervise the use of radiation sources.
2. To require that the acquisition of radiation sources be approved by the RSO and that all receipts and transfers, including disposal of radioisotopes be channelled through the RSO.

Specific procedures and practices have been established for most routine or recurrent situations to assure compliance with the regulations and company policy. For unusual situations, the RSO or the RSC will interpret the existing regulations, policies and procedures to establish guidelines.

The following procedures and practices have been established:

1. Authorization to Use Radioisotopes (Appendix I).
2. Training of workers (Appendix II).
3. Use of Radioisotopes (Appendix III).

Professional Standards.

The RSO also uses as operational guides the published data and recommendations of professionally recognized national and international committees and organizations concerned with health physics or radiation protection, examples of which are:

1. National Council on Radiation Protection (NCRP).
2. International Committee on Radiation Protection (ICRP).
3. International Atomic Energy Agency (IAEA).

4. Health Physics Society (HPS).

APPENDIX I

Authorization to Use Sources of Radiation.

An individual can use or possess a source of radiation only after authorization. To be authorized, a supervisor must present evidence of proper training and submit an application to the RSO. After approval by the RSO and the RSC, the application will be forwarded to the NRC. The RSO, RSC and the NRC must approve the application to supervise work with radioactive materials before work with radioisotopes can begin. Permission to use radioactive materials under the authorization of a Supervisor must also be obtained before a supervised worker may begin working with radioisotopes. Potential supervised users must submit an application including a summary of training and experience in the use of radioactive materials to the RSO who will then forward the application to the RSC. The EniChem RSC will consider the application and any recommendation of the RSO in determining whether to grant the applicant permission to use radioactive materials.

The authorization of a Supervisor will be reviewed and updated when the company NRC license is submitted for renewal. If the Supervisor wishes to use sources of radiation different from those for which he has been authorized, if he wishes to increase the possession limits or change the experimental conditions, he must receive an amendment to his authorization before the change can be put into effect. The RSO will evaluate requests for amendment and as necessary inform and request approval from the NRC for amendments to the company license.

A copy of the application for authorization is on the next page.

APPLICATION FOR USE OF RADIOISOTOPES

Instructions: Complete application form; submit it to RSO.
Authorization requires compliance with the
EniChem Radiation Safety Guide.

1. Name of Applicant	3. Location(s) where isotopes will be used.
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2. Group of Applicant	4. Location(s) where isotopes will be stored
-----------------------	---

5. Name of person supervising radioisotope usage.

6. Radioactive material(s).

Chemical symbol and mass Number of each	Chemical/Physical Form of material(s)	Possession Limit (mCi)

7. How the material will be used. Give sufficient detail concerning the use to provide a basis for the evaluation of the health hazards and possible building contamination. This should include a description of the experiment, the chemical and physical fates of the radioisotope, the maximum amounts of radioactivity to be used per experimental run and other information pertinent to radiation safety. Attach separate sheets as necessary.

8. Radiation Detection Instruments Used. ☐ GM survey meter
☐ Liquid Scintillation Counter ☐ Other (specify)

Special Restrictions _____

Special Monitoring Required _____

Approved By RSO _____ Date _____

APPENDIX II

Training of Workers

Individuals using radioisotopes under a NRC license have certain rights as prescribed in 10 CFR 19 "Notices, Instructions and Reports to Workers: Inspections" (see Appendix IV). In accordance with Part 19, a copy of the EniChem license and a copy of the Notice is posted in radioisotope areas to advise persons in those areas that work is being done and to describe the documents and regulations pertinent to that work.

EniChem has designed its training program to ensure that all persons working in or frequenting areas of radioisotope use are aware of the attendant hazards. All persons using radioisotopes or frequenting areas where radioisotopes are used must attend an EniChem Radiation Safety lecture consisting of material as shown in the outline appearing in this appendix before beginning work with radioactive materials. The RSO shall keep records of attendance at these orientations.

The RSO shall determine at the time of application for authorization amendment or renewal if the training and experience of the user is adequate or if additional training or experience is required.

OUTLINE FOR RADIATION SAFETY ORIENTATION LECTURE

1. Why are we here?
 - a. Regulations
 - b. Orientation to EniChem Radiation Safety Program
2. All uses of radiation in New Jersey require a license
3. Description of EniChem license
4. Licenses require EniChem to ensure safe use through:
 - a. Organization
 - b. Facilities and Equipment
 - c. Evaluation
 - d. Control
 - e. Services
5. Radioactivity and Radioactive Decay
6. Interaction of radiation with matter
7. Dosimetry
 - a. The Roentgen, the Rad, and the Rem
 - b. Methods of Measurement
8. Biological Effects
 - a. Somatic
 - b. Genetic
9. Regulations - based on ICRP and NCRP recommendations
 - a. 10 CFR 20
 - b. 10 CFR 19
 - c. Radiation Protection Guides
 1. 8.10 As Low As Reasonably Achievable
 2. 8.13 Pregnant Women
 - d. Postin-
 - e. Privacy Act; NRC Forms 4 and 5
10. EniChem Radiation Safety Program
 - a. Management responsibility
 - b. Radiation Safety Officer/Radiation Safety Committee
 - c. Evaluation
 - d. Compliance
 - e. Services
11. Laboratory Practices
 - a. External hazards, including X-rays
 - b. Internal hazards
 - c. Surveys
 - d. Instrumentation
 - e. Records
 - f. Waste Disposal
 - g. Labelling and marking

- h. Storage
- i. Restriction of access
- j. ALARA - As low as reasonably achievable
- k. Posted Emergency Procedures

12. Specific Problems

- a. Tritium (^3H)
- b. ^{14}C Carbon
- c. ^{32}P
- d. Concept of MPC and regulatory requirements
- e. Radiation Exposure Artifacts
- f. Care of Personnel Badges
- g. Ordering Radioisotopes
- h. Marking of waste containers
- i. Changes in experimental procedure
- j. Hesitance to ask for help/Where to get help
- k. Rules for use of radioisotopes

CAUTION

Work with sources of radiation is being carried out in this area.

In accordance with the United States Nuclear Regulatory Commission Regulation 10 CFR 19.11, the following documents relating to the work are available to you from the Radiation Safety Officer:

1. 10 CFR 20 - which describes the Nuclear Regulatory Commission Standards for Radiation Protection which must be adhered to in the use of sources of radiation.
2. 10 CFR 19 - which describes the Nuclear Regulatory Commission Regulations pertaining to notices, instructions, and reports to workers and inspections of radiation activities.
3. Regulatory License and Applications - which specify the special conditions under which radiation work must be carried out.
4. EniChem Radiation Safety Guide - which specifies laboratory radiation safety policies and procedures.
5. EniChem Authorization - under which the work in this area is being performed.

MAINTENANCE STAFF

PROCEDURES FOR DEALING WITH EQUIPMENT IN LABORATORIES USING RADIOACTIVE MATERIALS

1. Any device or area in our facility which has a radiation symbol on it might be contaminated with radioactive material. Before you work on or around such a device contact the Radiation Safety Officer (RSO) so that the device may be checked for safety.
2. Equipment within or servicing a radioisotope laboratory which may be contaminated by radioactive material includes hoods, exhaust blower motors, pumps, drain pipes, ventilation ducts, etc. Call the RSO to check before beginning work on such equipment.
3. If you think you may have gotten some radioactive material on your skin or clothing, wash it off as soon as possible, and then call the RSO so that he can assure you that all the contamination has been removed. Do not leave the general area until you have been checked. Do not panic. The risk is quite low.
4. If you have questions, call the RSO.

CUSTODIAL STAFF

WHAT TO DO ABOUT RADIOACTIVE MATERIALS

1. Rooms which have the radiation symbol shown on doors or on equipment may contain radioactive materials. You should be careful when working in these rooms. You can sweep, mop, and wax the floors and remove the waste which is not labelled with the radiation symbol, just as in any other room.
2. Any container (box, bottle, carton, etc.) which has radioactive material in it will have the radiation symbol on it also. You should not touch these containers. If the contents of these containers are spilled, DO NOT TOUCH THEM OR ATTEMPT TO CLEAN THEM UP. Tell your supervisor or the Radiation Safety Officer (RSO) right away.
3. DO NOT empty any waste container which has the radiation symbol on it.
4. DO NOT empty any waste container which has waste material, such as boxes or bottles, which are labelled with the radiation symbol. Tell your supervisor about it.
5. DO NOT eat, drink, smoke, take medication or apply cosmetics in any room which has the radiation symbol on its door.
6. In an emergency, or if you have any questions, ask your supervisor or the RSO for help.

APPENDIX III

Use of Radioisotopes

The Authorized Supervisor is responsible for seeing that the users of radioisotopes under his authorization comply with all the governmental regulations, the specific conditions and limitations of his authorization and the procedures and practices outlined in this Appendix. He verifies that all persons who use radioisotopes under the coverage of his authorization are supervised, properly trained and experienced, aware of the attendant hazards and observe the procedures of this guide.

1. Training and experience. See Appendix II of this guide.
2. Receipt, Transfer and Disposal of Radioactive Material.

The RSO must approve all purchases, receipts and subsequent transfers of radioisotopes. All requests to purchase radioisotopes must be submitted to the RSO. Purchase requests sent to the purchasing department without RSO approval will not be processed. A purchase requisition cannot be used to confirm a radioisotope order unless the authorized user obtains prior written approval from the RSO. Blanket orders for radioisotopes must be approved by the RSO before the order is placed.

All radioisotopes are checked for contamination and their receipt is recorded for legal purposes by the RSO. The radioisotope is then delivered to the authorized supervisor. See Appendix IV for procedures and forms.

If an authorized supervisor wants to either a) move the radioisotope to a location other than those specified on his authorization, or b) transfer the isotope to another authorized person, he must first obtain approval from the RSO.

All radioactive material must be disposed of through the RSO. No radioactive waste may be disposed down the drain or into the normal non-radioactive waste receptacles. Liquid waste must be placed in a properly labelled container. Solid waste must be placed in a properly labelled container lined with a plastic bag. Liquid scintillation vials should be kept separate. All radioactive waste will be packaged according to the specification of waste-removal vendors for removal to a disposal site.

3. Radiation Surveys.

The RSO supervises routine radiation and contamination surveys of all laboratories. The user must supplement these routine surveys as specified below. These user-conducted radiation surveys are not optional but are a required, integral part of the EniChem Radiation Safety Program.

RADIATION SURVEYS ARE TO BE MADE AFTER EACH EXPERIMENTAL RUN OR AT THE END OF EACH DAY. RADIOISOTOPES ARE USED IN ORDER TO DETERMINE THE EXTENT OF RADIOACTIVE CONTAMINATION AND TO ASCERTAIN THAT ALL WASTE AND STOCK MATERIAL HAS BEEN STORED OR PROPERLY DISPOSED OF.

When material is known to have been spilled or become airborne, wipe test surveys of the affected areas should be made. Such tests can be made with filter paper or squares of any absorbant paper, and the wipes counted with an appropriate counting instrument. The RSO should be called if the experimenter has reason to believe his work has resulted in gross contamination or constitutes an emergency situation (See emergency procedures below).

4. Storage of Radioisotopes.

Radioisotopes must be stored to permit access only to the authorized user and those whom he designates. Each area and room where radioisotopes are stored must be posted with a Radioactive Material sign. Radiation levels around storage and useage areas should be measured and, if radiation doses could exceed five (5) millirems per hour in an occupied area, be posted with a Radiation Area sign. Proper signs are available from the RSO.

See Appendix IV for Radioisotope Inventory Forms.

5. Records.

Each user shall maintain a radioisotope log to record the receipt, use and disposal of all radioisotopes he receives. This is not optional but is a governmental regulation. The log should also be used to record the date and results of radiation and contamination surveys, even when the results show no radiation or contamination. This log is subject to inspection by the RSO and the NRC. See Appendix IV for examples of these logs.

6. Restriction of Radioisotope Areas.

Access to areas where radioisotopes are stored or used must be restricted to those persons cognizant of the associated hazards. This is a federal regulation.

7. Radioactive Waste.

Radioactive waste must be disposed of through the RSO. No waste is to be discarded through the drains or any other means without prior approval from the RSO. A copy of the waste inventory log is in Appendix IV.

8. Movement of Radioisotopes.

Radioisotopes are not to be moved from authorized places of storage and use without the prior approval of the RSO. Under no circumstances is any radioactive material or equipment contaminated with radioactive material to be removed from the laboratory site by any method including but not limited to the mails, UPS or other contract carrier or personal or company vehicle without prior approval of the RSO.

9. Emergency Procedures.

A radiation emergency occurs when a set of circumstances results in hazardous radiation levels, hazardous concentrations of airborne radioisotopes, or gross contamination of property. Examples of radiation emergencies and actions to be taken are:

- a. Personnel Contamination
 - 1) Remove contaminated clothing.
 - 2) Wash contaminated skin with mild soap and water.
Do not use abrasives.
 - 3) Call the RSO.
- b. Spill of radioisotope where radioisotope does not become airborne.
 - 1) Wipe up spill with absorbant paper using a blotting motion so you do not spread the contamination.
 - 2) Dispose of the contaminated paper in a radioactive waste container.
 - 3) Call the RSO
- c. Volatilization of liquid or dispersal of solid radioisotope outside a ventillated enclosure.
 - 1) If possible, keep contamination localized by closing doors and restricting access to area.
 - 2) Leave the area.
 - 3) Call the RSO.
- d. Fire in a radioisotope area.
 - 1) Treat the fire in the normal manner.
 - 2) Call the RSO.

ALWAYS USE COMMON SENSE IN HANDLING RADIATION EMERGENCIES, AND CALL THE RSO AS SOON AS PRACTICAL. DO NOT TRACK OR OTHERWISE PERMIT RADIOISOTOPES TO BE SPREAD INTO CLEAN AREAS.

10. Personnel monitoring.

The RSO determines the need for personnel dosimetry during the authorization evaluation or evaluation of amendment requests.

The authorized Supervisor has the responsibility to assure that all persons who use radioisotopes or work in his area wear appropriate radiation dosimeters when required. The details are shown in Appendix IV.

11. Radioisotope laboratory design.

The design and furnishings of a laboratory must be commensurate with the hazards presented by the radioisotope and its condition of use. Each laboratory must therefore be evaluated individually by the RSO in light of its intended use. In practical terms, some possible requirements are that:

- a. Bench tops or other surfaces on which radioisotopes will be used should be stainless steel or covered with an impervious surface.
- b. Floors must be covered with an impervious material; properly waxed, vinyl asbestos tiles are normally acceptable.
- c. Walls must have a smooth, crack- and hole-free surface.
- d. Proper room ventilation and adequate radioisotope storage must be provided.

12. Rules for working with radioactive materials.

A set of laboratory rules found to be very useful in reminding laboratory workers of good radiation safety practices is found below. Copies of these pages should be posted in each laboratory the by RSO. Each authorized supervisor should ensure that these instructions are kept prominently displayed in work areas.

Special procedures for working with millicurie amounts of ^{32}P -labelled compounds are in Appendix IV.

RULES FOR WORKING WITH RADIOACTIVE MATERIALS

ROUTINE PROCEDURES

- | | |
|---|--|
| Eating, drinking,
smoking, etc. | 1. Eating, drinking, smoking, chewing gum, taking medication, applying cosmetics are not permitted in this laboratory. |
| Wash hands | 2. Wash hands after handling any radioactive material before going about other work. Always wash before handling objects which go into the mouth, nose, or eyes. Keep fingernails short and clean. |
| Pipetting | 3. <u>Never</u> pipette anything, even water, by mouth. |
| Protective clothing | 4. Always wear rubber or plastic gloves and lab coats when handling radioisotopes. Lab coats and gloves should only be worn in the laboratory and should be removed when leaving the lab. |
| Confine the activity | 5. Always work over trays lined with absorbant material. Keep and transport radioactive materials in double containers. |
| Spills | 6. Notify the Radiation Safety Officer <u>of all spills</u> except those of a very minor nature. |
| Labelling | 7. Using radioactive labelling tape, label radioactive materials with your name, date, isotope and quantity of isotope. |
| Before leaving | 8. Before leaving the laboratory, clean up and monitor your work area as well as yourself. |
| Dispose of <u>liquid</u>
radioactive waste | 9. Liquid radioactive materials should be disposed of through the RSO. They should be held in plastic containers or in metal containers if the material is incompatable with plastic. The quantity of isotope, the isotope name, the date, and the user's name should be |

recorded in a log kept with the container. No radioactive material should be disposed of via the sink.

Dispose of solid
radioactive waste

10. Solid radioactive waste should be placed in plastic-lined boxes or containers. The quantity being disposed of, the date, the user, and the isotope should be recorded in the waste log kept with the container.

Hoods

11. Materials which could become airborne must be stored and used in a hood. Hood ventilation should be left on at all times.

Food

12. Never keep or store food or beverages in radioisotope labs, or in refrigerators or freezers in which radioisotopes are or have been stored.

RULES FOR WORKING WITH RADIOACTIVE MATERIALS

EMERGENCY PROCEDURES

Be prepared for an emergency by mentally rehearsing the following:

EXTREME HAZARDS

Hazards such as high radiation levels or the possibility of airborne contamination from dry or volatile radioactive materials.

- | | |
|----------|--|
| EVACUATE | 1. Evacuate the laboratory immediately; secure the doors to prevent reentry. |
| CALL RSO | 2. Call the RSO immediately. If you have to leave the area to do so, remove your shoes if you suspect contamination and do not touch anything unnecessarily. |

OTHER HAZARDS

Hazards such as spills or suspected spills of radioactive material where the material does not become airborne.

- | | |
|-----------------------|--|
| Keep Calm | 1. Keep calm, use common sense, protect people, do not spread contamination (always assume you are contaminated until a survey proves otherwise). |
| Confine Contamination | 2. Localize the spill. Right tipped containers; drop absorbant material onto the spill. Damp down a dry spill.

Do not track contamination about the laboratory.

<u>Call, don't go for help if possible.</u>

Close door and where possible adjust the ventillation to prevent spread of airborne materials.

Check shoes before leaving the area of a "cleaned" spill. |
| Protect Personnel | 3. Remove contaminated clothing and wash contaminated parts of the body with a mild detergent. |

Be especially thorough in flushing out wounds.

Warn other workers.

Decontaminate

4. If thorough washing with detergent does not remove contamination from body, consult the RSO.

You will be expected to perform the major work of decontamination of the area of your spill. The RSO will survey for contamination and advise on procedures and assist as necessary.

All suspected contaminated persons and areas must be monitored after decontamination and before work is resumed.

IN ALL EMERGENCIES, EXCEPT VERY MINOR SPILLS OF RADIOACTIVE MATERIALS, THE RSO SHOULD BE CALLED AS SOON AS POSSIBLE.

DO NOT TRACK OR OTHERWISE PERMIT RADIOISOTOPES TO BE SPREAD INTO CLEAN AREAS.

APPENDIX IV

SPECIAL PROCEDURES AND FORMS

Radioactive Material Receipt and Delivery Procedure and Forms

Laboratory Survey Procedure and Form

Radioactive Material Inventory Form

Radioactive Material Waste Form

Procedures for Use of ^{32}P in Quantities above 1 mCi

Personnel Monitoring Details

RADIOACTIVE MATERIAL RECEIPT AND OPENING PROCEDURE

I. Package Receipt

- A. Do not accept a radioisotope shipment that is damaged.
- B. A contamination survey must be made within three (3) hours after receipt of a radioactive material shipment (within 18 hours if the delivery is made after hours).
- C. Radioactive material shipments should be separated from the non-radioactive shipments upon receipt. The RSO should be notified immediately.
- D. The date and time of the receipt should be recorded on the delivery form.

II. Package opening

- A. Wear gloves and protective clothing when opening the package.
- B. Wipe the outside shipping container surface and count the wipes to check for contamination (see note below). Record the results.
- C. Using the G.M. survey meter, measure the radiation levels at the surface of the container and, if necessary, at one meter from the surface. Record the results.
- D. Open the package, and take a wipe of the successive layers of containment, down to the vial containing the radioisotope (or the outside of the package if it is sterile-wrapped). Count these and record the results.
- E. Record and signs of damage to the package or the vial.
- F. If there is contamination or an excessive radiation level check the NRC regulations (10 CFR 20.205) to see if the NRC or the shipper must be notified.
- G. See 10 CFR 20.205 for circumstances in which some of these steps may be eliminated or reduced.
- H. The wipes should be counted in the Liquid Scintillation Counter.

III. Delivery of Radioisotopes to user.

- A. Do not leave the package unattended; deliver it immediately to the user so that it may be stored correctly.

RADIOISOTOPE RECEIPT AND DELIVERY

Radioactive Material_____

P.O. No. _____

Activity_____

Date of receipt_____

Location of use_____

Contamination Survey (counts per minute)

Package surface

Final source container

Background

Radiation Levels (mR/hr)

Package surface

Three feet

Background

Date and Time of
Delivery to user_____

User signature_____

LABORATORY SURVEY PROCEDURE

1. Laboratory contamination surveys should be done on a routine periodic basis with the period determined by the level of activity. They should be done often enough so that possibility of contamination is minimized.

Surveys should be done by anyone using radioactive material immediately after the completion of an experimental procedure.

2. The survey data, consisting of layouts of the laboratories indicating the locations at which the wipes were made and the results of the counting of the wipes must be kept for inspection by the RSO and the NRC. If contamination is found, it should be removed immediately and the area resurveyed. The results of the resurvey should be recorded.
3. Wipes are made using filter paper moistened with water or, if necessary, another appropriate solvent for the material in use. Approximately 100 cm² (10 cm x 10 cm; 20 cm x 5 cm; 100 cm x 1 cm; etc.) of surface should be wiped.
4. Penetrating radiation, e.g. ³²P, can be monitored with the G.M. survey meter.

LABORATORY SURVEY RECORD

Room _____ Supervisor _____

Radioisotope used _____

(See room plan on reverse side for key to locations.)

<u>Survey Date</u>	<u>Surveyor</u>	<u>Contamination</u> Loc. dpm/wipe	<u>Radiation Field</u> Loc. mR/hr	<u>Background</u> mR/hr
--------------------	-----------------	---------------------------------------	--------------------------------------	----------------------------

1. On the reverse side sketch a plan of the lab indicating by number the locations at which the wipes are taken.
2. Contamination surveys shall be done using absorbant filter paper (moistened with an appropriate solvent if necessary). Wipe approximately 100 cm² of surface area. Count the wipes in the liquid scintillation counter. An activity of 200 dpm/wipe or greater indicates significant contamination. Contaminated areas must be cleaned immediately and the area resurveyed.
3. Radiation surveys (if necessary) should be performed with a properly operating, calibrated G.M. survey instrument. An exposure rate in excess of 0.1 mR/hr in areas frequently occupied by humans should be shielded.

Material _____ User _____

Initial amount _____ Date received _____ PO No. _____

[illegible]

Disposed of empty container
Date: _____

User _____

RADIOACTIVE WASTE INVENTORY

<u>Date</u>	<u>Radioisotope</u>	<u>Activity</u>	<u>User</u>
-------------	---------------------	-----------------	-------------

Totals: (To be completed when the radioactive waste is shipped.)

<u>Radioisotope</u>	<u>Total Activity (mCi)</u>
---------------------	-----------------------------

Signature_____

Date_____

HANDLING PROCEDURES FOR MILLICURIE QUANTITIES OF ^{32}P

Phosphorus-32 emits a distribution of energetic beta particles up to a maximum energy of 1.7 MeV, which can travel as far as 7 meters in air. The absorbed dose rate close to containers of millicurie quantities of ^{32}P is on the order of rads/min. A significant fraction of ^{32}P entering the body is deposited in the bone structure. The maximum permissible bone burden is 6 microcuries.

The following procedures should offer a guide to using sources of ^{32}P in excess of one millicurie.

1. Prepare a written set of procedures and submit them to the RSO for approval prior to the run.
2. Avoid handling the vial directly. Use remote handling tools, such as tongs or special holders when handling the source containers.
3. Use low density shielding (e.g. a minimum of 0.25 in. of plexiglas) to absorb the beta particles without generating significant amounts of X-rays due to Bremsstrahlung. Heavy materials (high atomic number) should not be used close to the source because the Bremsstrahlung process results in much greater X-ray production in high density material than in low density shielding material. However, a small amount of lead on the outside of a plastic shield will absorb the Bremsstrahlung X-rays efficiently.
4. Wear Safety Glasses to protect eyes from splashes and unnecessary radiation.
5. Wear two sets of gloves; strip off the outer pair and replace if they become contaminated. Keep the inner pair clean at all times.
6. Have immediately available a properly operating G.M. survey meter for use in detecting contamination and radiation fields.
7. Wear finger dosimeters in addition to lapel film badges. The finger dosimeters are important because they will monitor the dose given to the fingers which will not be seen by the lapel badge.
8. Have your supervisor or the RSO observe you during a dry run of the procedure or the first time you perform the procedure.
9. After each procedure, survey the area with both the G.M. and wipes to enable removal of any contamination.

PERSONNEL MONITORING

Personnel badges will be worn by all persons using millicurie amounts of ^{32}P to assure that all exposures are minimized. It is unlikely that anyone will be exposed to levels which will result in doses above the limits of 10 CFR 20.202 so badges will be worn to establish good radiation safety practices. Finger dosimeters will be required for millicurie quantity ^{32}P users.

Urine analysis or other appropriate bioassays will be done in the event of a suspected accidental intake of a radionuclide. The standard procedure for urine analysis is to count a one (1) ml sample of the individual's urine by liquid scintillation counting. The minimum detectable body burdens for the isotopes of Item 8 are calculated below.

Tritium: The MDL is $\frac{50 \text{ dpm/ml}}{2.22 \times 10^6 \text{ dpm/uCi}} = 2.2 \times 10^{-5} \text{ uCi/ml}$

which corresponds to a whole body water burden of approximately 0.095 uCi. This threshold is well below the Maximum Permissible Body Burden of 1000 uCi (ICRP 10). Analysis of other organ burdens of Tritium will be done using the latest reference data, e.g. NCRP or ICRP documents.

Carbon-14:

Sulfur-35: The MDL is $\frac{100 \text{ dpm/ml}}{2.22 \times 10^6 \text{ dpm/uCi}} = 0.05 \times 10^{-3} \text{ uCi/ml}$

Phosphorus-32:

which corresponds to whole body burdens in excess of the Maximum Permissible Body Burdens (ICRP 10) of 400 uCi for ^{14}C and ^{35}S and 30 uCi for ^{32}P . Because of the relatively high threshold of the urine assay for these radionuclides and the small probability that a significant fraction of the Maximum Permissible Body Burdens would be taken into the body of a radiation worker in situations other than accidents, urine assays for these isotopes will be done only if there is a suspicion that accidental intake may have occurred.

APPENDIX V.

U.S. Nuclear Regulatory Commission Regulations and Guides

10 CFR 20

10 CFR 19

Regulatory Guide 8.10

Regulatory Guide 8.13

REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 8.13

INSTRUCTION CONCERNING PRENATAL RADIATION EXPOSURE

A. INTRODUCTION

Section 19.12 of 10 CFR Part 19 states that all individuals working in or frequenting any portion of a restricted area must be instructed in the health protection problems associated with exposure to radioactive materials or radiation. This guide describes the instruction that should be provided concerning biological risks to embryos or fetuses resulting from prenatal exposure.*

B. DISCUSSION

Since the Law of Bergonie and Tribondeau was published in 1906** it has been known that the sensitivity of cells to radiation damage is related to their reproductive activity and inversely related to their degree of differentiation. It follows that children could be expected to be more radiosensitive than adults, fetuses more radiosensitive than children, and embryos even more radiosensitive.

This principle has long been a factor in the development of radiation exposure standards. Section 20.104 of 10 CFR Part 20 places different limits on minors than on adult workers. Specifically, it limits anyone under the age of 18 to exposures not exceeding 10% of the limits for adult workers. However, §20.104 does not relate to embryos or fetuses.

A special situation arises when an occupationally exposed woman is pregnant. Exposure of the abdomen of such a worker to penetrating radiation from either external or internal sources would also involve exposure of the embryo or fetus. Because a number of studies have indicated that the embryo or fetus is more sensitive

than an adult, particularly during the first three months after conception, when a woman may not be aware that she is pregnant, the National Council on Radiation Protection and Measurements (NCRP) recommended in its Report No. 39 that special precautions be taken to limit exposure when an occupationally exposed woman could be pregnant.

C. REGULATORY POSITION

Instruction to workers performed under §19.12 should be given prior to assignment to work in a restricted area. In providing instruction about health protection problems associated with radiation exposure, female workers and those who may supervise or work with them should be given specific instruction about prenatal exposure risks to the developing embryo and fetus.

The instruction should ensure that the employees understand:

1. That the NCRP has recommended that, during the entire gestation period, the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother should not exceed 0.5 rem and
2. The reasons for this recommendation.

The instruction should include the information provided in the Appendix to this guide. It should be presented to the employee, her supervisors, and her co-workers both orally and in written form. Each individual should be given an opportunity to ask questions, and each individual should be asked to acknowledge in writing that the instruction has been received.

D. IMPLEMENTATION

The purpose of this section is to provide information to licensees regarding the use of this guide.

*This revision of the guide includes minor changes of a clarifying nature incorporated as a result of public comments. No substantive changes have been made.

***Comptes Rendus des Seances de l'Academie des Sciences*, Vol. 143, pp. 983-985, 1906.

USNRC REGULATORY GUIDES

Regulatory Guides are issued to describe and make available to the public methods acceptable to the NRC staff of implementing specific parts of the Commission's regulations, to delineate techniques used by the staff in evaluating specific problems or postulated accidents, or to provide guidance to applicants. Regulatory Guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission.

Comments and suggestions for improvements in these guides are encouraged at all times, and guides will be revised as appropriate to accommodate comments and to reflect new information or experience. This guide was revised as a result of substantive comments received from the public and additional staff review.

Comments should be sent to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Section.

The guides are issued in the following ten broad divisions:

- | | |
|-----------------------------------|------------------------|
| 1. Power Reactors | 6. Products |
| 2. Research and Test Reactors | 7. Transportation |
| 3. Fuels and Materials Facilities | 8. Occupational Health |
| 4. Environmental and Siting | 9. Antitrust Review |
| 5. Materials and Plant Protection | 10. General |

Copies of published guides may be obtained by written request indicating the divisions desired to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Director, Office of Standards Development.

7812190209 5pp.

Except in those cases in which the licensee chooses to propose an alternative method for complying with the portion of the Commission's regulations previously specified, the methods described herein should be used immediately to instruct female employees working in or

frequenting any portion of a restricted area, and those who may supervise or work with such employees, concerning the health protection problems associated with prenatal radiation exposure.

APPENDIX TO REGULATORY GUIDE 8.13

POSSIBLE HEALTH RISKS TO CHILDREN OF WOMEN
WHO ARE EXPOSED TO RADIATION DURING PREGNANCY

Some recent studies have shown that the risk of leukemia and other cancers in children increases if the mother is exposed to a significant amount of radiation during pregnancy. According to a report by the National Academy of Sciences, the incidence of leukemia among children from birth to 10 years of age in the United States could rise from 3.7 cases in 10,000 children to 5.6 cases in 10,000 children if the children were exposed to 1 rem of radiation before birth (a "rem" is a measure of radiation). The Academy has also estimated that an equal number of other types of cancers could result from this level of radiation. Although other scientific studies have shown a much smaller effect from radiation, the Nuclear Regulatory Commission wants women employees of its licensees to be aware of any possible risk so that the women can take steps they think appropriate to protect their offspring.

As an employee of a Nuclear Regulatory Commission licensee, you may be exposed to more radiation than the general public. However, the Nuclear Regulatory Commission has established a basic exposure limit for all occupationally exposed adults of 1.25 rems per calendar quarter, or 5 rems per year. No clinical evidence of harm would be expected in an adult working within these levels for a lifetime. Because the risks of undesirable effects may be greater for young people, individuals under 18 years of age are permitted to be exposed to only 10 percent of the adult occupational limits. (This lower limit is also applied to members of the general public.)

The scientific organization called the National Council on Radiation Protection and Measurements has recommended that because unborn babies may be more sensitive to radiation than adults, their radiation dose as a result of occupational exposure of the mother should not exceed 0.5 rem. Other scientific groups, including the International Commission on Radiation Protection, have also stressed the need to keep radiation doses to unborn children as low as is reasonably achievable.

All Nuclear Regulatory Commission licensees are now required* to inform all individuals who work in a restricted area of the health protection problems associated with radiation exposure. This instruction would in many cases include information on the possible risks to unborn babies. The regulations also state** that licensees should keep radiation exposures as low as is reasonably achievable. According to the National Council on Radiation Protection and Measurements, vigorous efforts should be made to keep the radiation exposure of an embryo or fetus at the very lowest practicable level during the entire period of pregnancy.

Thus it is the responsibility of your employer to take all practicable steps to reduce your radiation exposure. Then it is your responsibility to decide whether the exposure you are receiving is sufficiently low to protect your unborn child. The advice of your employer's health physicist or radiation protection officer should be obtained to determine whether radiation levels in your working areas are high enough that a baby could receive 0.5 rem or more before birth. If so, the alternatives that you might want to consider are:

(a) If you are now pregnant or expect to be soon, you could decide not to accept or continue assignments in these areas.

(b) You could reduce your exposure, where possible, by decreasing the amount of time you spend in the radiation area, increasing your distance from the radiation source, and using shielding.

(c) If you do become pregnant, you could ask your employer to reassign you to areas involving less exposure to radiation. If this is not possible, you might consider

* By Title 10, Part 19 of the Code of Federal Regulations.

**In Title 10, Part 20.

leaving your job. If you decide to take such steps, do so without delay. The unborn child is most sensitive to radiation during the first three months of your pregnancy.

(d) You could delay having children until you are no longer working in an area where the radiation dose to your unborn baby could exceed 0.5 rem.

You may also, of course, choose to:

(e) Continue working in the higher radiation areas, but with full awareness that you are doing so at some small increased risk for your unborn child.

The following facts should be noted to help you make a decision:

1. The first three months of pregnancy are the most important, so you should make your decision quickly.

2. In most cases of occupational exposure, the actual dose received by the unborn baby is less than the dose received by the mother because some of the dose is absorbed by the mother's body.

3. At the present occupational exposure limit, the actual risk to the unborn baby is small, but experts disagree on the exact amount of risk.

4. There is no need to be concerned about sterility or loss of your ability to bear children. The radiation dose required to produce such effects is more than 100 times larger than the Nuclear Regulatory Commission's dose limits for adults.

5. Even if you work in an area where you receive only 0.5 rem per three-month period, in nine months you could receive 1.5 rems, and the unborn baby could receive more than 0.5 rem, the full-term limit suggested by the NCRP. Therefore, if you decide to restrict your unborn baby's exposure as recommended by the NCRP, be aware that the 0.5 rem limit to the unborn baby applies to the full nine-month pregnancy.

The remainder of this document contains a brief explanation of radiation and its effects on humans. As you will see, some radiation is present everywhere and the levels of radiation most employees of Nuclear Regulatory Commission licensees receive are not much larger than these natural levels. Because the radiation levels in the facility where you will be working are required by law to be kept quite low, there is not considered to be a significant health risk to individual adult employees.

The amount of radiation an individual receives is called the "dose" and is measured in "rems." The average individual in the United States accumulates a dose of one rem from natural sources every 12 years. The dose from natural radiation is higher in some states, such as Colorado, Wyoming, and South Dakota, primarily because of cosmic radiation. There the average individual gets one rem every 8 years.

Natural background radiation levels are also much higher in certain local areas. A dose of one rem may be received in some areas on the beach at Guarapari, Brazil, in only about 9 days, and some people in Kerala, India, get a dose of one rem every 5 months.

Many people receive additional radiation for medical reasons. In 1970, an estimated 212 million X-ray examinations were performed in the United States. The estimated average surface skin dose from one radiographic chest X-ray is 0.027 rem. The estimated average surface skin dose per abdominal X-ray is 0.62 rem.*

Radiation can also be received from natural sources such as rock or brick structures, from consumer products such as television and glow-in-the-dark watches, and from air travel. The possible annual dose from working 8 hours a day near a granite wall at the Redcap Stand in Grand Central Station, New York City, is 0.2 rem, and the average annual dose in the United States from TV, consumer products, and air travel is 0.0026 rem.

Radiation, like many things, can be harmful. A large dose to the whole body (such as 600 rems in one day) would probably cause death in about 30 days, but such large doses result only from rare accidents. Control of exposure to radiation is based on the assumption that any exposure, no matter how small, involves some risk. The occupational exposure limits are set so low, however, that medical evidence gathered over the past 50 years indicates no clinically observable injuries to individuals due to radiation exposures when the established radiation limits are not exceeded. This was true even for exposures received under the early occupational exposure limits, which were many times higher than the present limits. Thus the risk to individuals at the occupational exposure levels is considered to be very low. However, it is impossible to say that the risk is zero. To decrease the risk still further, licensees are expected to keep actual exposures as far below the limits as is reasonably achievable.

*Pre-Release Report: X-Ray Exposure Study (XES) Revised Estimates of 1964 and 1970 Genetically Significant Dose, February 4, 1971, U.S. Department of Health, Education, and Welfare, Public Health Service, Federal Drug Administration, Bureau of Radiological Health.

The current exposure limits for people working with radiation have been developed and carefully reviewed by nationally and internationally recognized groups of scientists. It must be remembered, however, that these limits are for adults. Special consideration is appropriate when the individual being exposed, is, or may be, an expectant mother, because the exposure of an unborn child may also be involved.

Prenatal Irradiation

The prediction that an unborn child would be more sensitive to radiation than an adult is supported by observations for relatively large doses. Large doses delivered before birth alter both physical development and behavior in experimentally exposed animals. A report of the National Academy of Sciences states that short-term doses in the range of 10 to 20 rems cause subtle changes in the nerve cells of unborn and infant rats. The report also states, however, that no radiation induced changes in development have been demonstrated to result in experimental animals from doses up to about 1 rem per day extended over a large part of the period before birth.

The National Academy of Sciences also noted that doses of 25 to 50 rems to a pregnant human may cause growth disturbances in her offspring. Such doses substantially exceed, of course, the maximum permissible occupational exposure limits.

Concern about prenatal exposure (i.e., exposure of a child while in its mother's uterus) at the permissible occupational levels is primarily based on the possibility that cancer (especially leukemia) may develop during the first 10 years of the child's life. Several studies have been performed to evaluate this risk. One study involved the followup of 77,000 children exposed to radiation before birth (because of diagnostic abdominal X-rays made for medical purposes during their mother's pregnancy). Another study involved the followup of 20,000 such children. In addition, 1292 children who received prenatal exposure during the bombing of Hiroshima and Nagasaki were studied. Although contradictory results have been obtained, most of the evidence suggests a relationship between prenatal exposure and an increased risk of childhood cancer.

Summary

Occupational exposures to radiation are being kept low. However, qualified scientists have recommended that the radiation dose to an embryo or fetus as a result of occupational exposure of the expectant mother should not exceed 0.5 rem because of possible increased risk of childhood leukemia and cancer. Since this 0.5 rem is lower than the dose generally permitted to adult workers, women may want to take special actions to avoid receiving higher exposures, just as they might stop smoking during pregnancy or might climb stairs more carefully to reduce possible risks to their unborn children.

Bibliography

1. Donald G. Pizzarello and Richard L. Witcofski, *Basic Radiation Biology*, Philadelphia: Lea and Febizer, 1967.
2. National Academy of Sciences - National Research Council, *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation*, Washington, D.C., November 1972.
3. National Council on Radiation Protection and Measurements, *Basic Radiation Protection Criteria*, NRC Report No. 39, Washington, D.C., January 15, 1971.
4. United Nations, *Ionizing Radiation: Levels and Effects*, 2 vol., Reports of the United Nations Scientific Committee on the Effects of Atomic Radiation, Report No. A/8725, United Nations, New York, 1972.
5. U.S. Atomic Energy Commission, Division of Technical Information, *Understanding the Atom Series:*

Atoms, Nature and Man

The Genetic Effects of Radiation

The Natural Radiation Environment

Your Body and Radiation

§ 20.1

§ 20.3(a)

PART 20

STANDARDS FOR PROTECTION AGAINST RADIATION

PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

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Authority: Secs. 53, 63, 65, 67, 103, 104, 181, 88 Stat. 930, 933, 934, 936, 937, 944, as amended; (42 U.S.C. 2073, 2083, 2086, 2111, 2133, 2134, 2201); secs. 2071, as amended, 202, 208, Pub. L. 90-434, 88 Stat. 1342, 1344, 1346, Pub. L. 94-79, 88 Stat. 413 (42 U.S.C. 8041, 8042, 8046).

For the purposes of sec. 223, 88 Stat. 944, as amended, (42 U.S.C. 2273), §§ 20.101, 20.102, 20.103(a) (b), and (f), 20.104 (a) and (b), 20.105(b), 20.106(a), 20.301, 20.302(a), 20.306, 20.307, 20.307, 20.308, 20.304 and 20.306 are issued under sec. 181b, 88 Stat. 944, as amended, (42 U.S.C. 2201(b)); and §§ 20.102, 20.103(a), 20.401-20.407, 20.408(b) and 20.409 are issued under sec. 181c, 88 Stat. 950, as amended, (42 U.S.C. 2201(c)).

GENERAL PROVISIONS

§ 20.1 Purpose.

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

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

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

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

§ 20.2 Scope.

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

§ 20.3

§ 20.3 Definitions.

(a) As used in this part:

(1) "Act" means the Atomic Energy Act of 1954 (68 Stat. 919) including any amendments thereto;

(2) "Airborne radioactive material" means any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors, or gases;

(3) "Byproduct material" means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material;

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

PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

(5) "Commission" means the Nuclear Regulatory Commission or its duly authorized representatives:

(6) "Government agency" means any executive department, commission, independent establishment, corporation, wholly or partly owned by the United States of America which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government:

(7) "Individual" means any human being:

(8) "Licensed material" means source material, special nuclear material, or by-product material received, possessed, used, or transferred under a general or specific license issued by the Commission pursuant to the regulations in this chapter:

(9) "License" means a license issued under the regulations in Parts 30 through 35.40, 60, 61, 70 or 72 of this chapter. "Licensee" means the holder of such license:

(10) "Occupational dose" includes exposure of an individual to radiation (i) in a restricted area, or (ii) in the course of employment in which the individual's duties involve exposure to radiation, provided that "occupational dose" shall not be deemed to include any exposure of an individual to radiation for the purpose of medical diagnosis or medical therapy of such individual.

(11) "Person" means: (i) Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission or the Department (except that the Department shall be considered a person within the meaning of the regulations in this part to the extent that its facilities and activities are subject to the licensing and related regulatory authority of the Commission pursuant to section 202 of the Energy Reorganization Act of 1974 (88 Stat. 1244)), any State, any foreign government or nation or any political subdivision of any such government or nation, or other entity; and (ii) any legal successor, representative, agent, or agency of the foregoing.

(12) "Radiation" means any or all of the following alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but not sound or radio waves, or visible, infrared, or ultraviolet light:

(13) "Radioactive material" includes any such material whether or not subject to licensing control by the Commission:

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

(15) "Source material" means: (i) Uranium or thorium, or any combination thereof, in any physical or chemical form; or (ii) ores which contain by weight one-twentieth of one percent (0.05%) or more of (a) uranium, (b) thorium or (c) any combination thereof. Source material does not include special nuclear material.

(16) "Special nuclear material" means: (i) Plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 51 of the act, determines to be special nuclear material, but does not include source material; or (ii) any material artificially enriched by any of the foregoing but does not include source material:

(17) "Unrestricted area" means any area access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters.

(18) "Department" means the Department of Energy established by the Department of Energy Organization Act (Pub. L. 95-91, 91 Stat. 565, 42 U.S.C. 7101 *et seq.*) to the extent that the Department, or its duly authorized representatives, exercises functions formerly vested in the U.S. Atomic Energy Commission, its Chairman, members, officers and components and transferred to the U.S. Energy Research and Development Administration and to the Administrator thereof pursuant to sections 104 (b), (c) and (d) of the Energy Reorganization Act of 1974 (Pub. L. 93-438, 88 Stat. 1233

at 1237, 42 U.S.C. 5814) and retransferred to the Secretary of Energy pursuant to section 301(a) of the Department of Energy Organization Act (Pub. L. 95-91, 91 Stat. 565 at 577-578, 42 U.S.C. 7151).

(19) "Termination" means the end of employment with the licensee or, in the case of individuals not employed by the licensee, the end of a work assignment in the licensee's restricted areas in a given calendar quarter, without expectation or specific scheduling of reentry into the licensee's restricted areas during the remainder of that calendar quarter.

(b) Definitions of certain other words and phrases as used in this part are set forth in other sections, including:

(1) "Airborne radioactivity area" defined in § 20.203;

(2) "Radiation area" and "high radiation area" defined in § 20.202;

(3) "Personnel monitoring equipment" defined in § 20.202;

(4) "Survey" defined in § 20.201;

(5) Units of measurement of dose (rad, rem) defined in § 20.4;

(6) Units of measurement of radioactivity defined in § 20.5.

§ 20.4 Units of radiation dose.

(a) "Dose," as used in this part, is the quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body. When the regulations in this part specify a dose during a period of time, the dose means the total quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body during such period of time. Several different units of dose are in current use. Definitions of units as used in this part are set forth in paragraphs (b) and (c) of this section.

(b) The rad, as used in this part, is a measure of the dose of any ionizing radiation to body tissues in terms of the energy absorbed per unit mass of the tissue. One rad is the dose corresponding to the absorption of 100 ergs per gram of tissue. (One millirad (mrad) = 0.001 rad.)

(c) The rem, as used in this part, is a measure of the dose of any ionizing radiation to body tissues in terms of its estimated biological effect relative to a dose of one roentgen (r) of X-rays. (One millirem (mrem) = 0.001 rem.) The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions of irradiation. For the purpose of the regulations in this part, any of the following is considered to be equivalent to a dose of one rem:

(1) A dose of 1 r due to X- or gamma radiation;

(2) A dose of 1 rad due to X-, gamma, or beta radiation;

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(3) A dose of 0.1 rad due to neutrons or high energy protons.

(4) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye. If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron dose in rads, as provided in paragraph (c)(3) of this section, one rem of neutron radiation may, for purposes of the regulations in this part, be assumed to be equivalent to 14 million neutrons per square centimeter incident upon the body; or, if there exists sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equivalent to one rem may be estimated from the following table:

NEUTRON FLUX DOSE EQUIVALENTS

Neutron energy (MeV)	Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm ²)	Average flux to deliver 100 millirem in 40 hours (neutrons/cm ² sec)
Thermal	870×10^4	570
0.001	720×10^4	500
0.005	820×10^4	570
0.02	400×10^4	280
0.1	120×10^4	80
0.5	43×10^4	30
1.0	76×10^4	18
2.5	19×10^4	20
5.0	26×10^4	18
7.5	24×10^4	17
10	24×10^4	17
10 to 30	14×10^4	10

(d) For determining exposures to X or gamma rays up to 3 Mev, the dose limits specified in §§ 20.101 to 20.104, inclusive, may be assumed to be equivalent to the "air dose". For the purpose of this part "air dose" means that the dose is measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of highest dosage rate.

§ 20.5 Units of radioactivity.

(a) Radioactivity is commonly, and for purposes of the regulations in this part shall be, measured in terms of disintegrations per unit time or in curies.

One curie = 3.7×10^{10} disintegrations per second (dps) = 2.2×10^{11} disintegrations per minute (dpm). Commonly used submultiples of the curie are the millicurie and the microcurie:

- (1) One millicurie (mCi) = 0.001 curie (Ci) = 3.7×10^7 dps.
- (2) One microcurie (μCi) = 0.000001 curie = 3.7×10^4 dps.

(b) [Deleted 40 FR 50704.]

(c) [Deleted 39 FR 23990.]

§ 20.6 Interpretations.

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

§ 20.7 Communications.

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

§ 20.8 Information collection requirements: OMB approval.

(a) The Nuclear Regulatory Commission has submitted the information collection requirements contained in this part to the Office of Management and Budget (OMB) for approval as required by the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 et seq.). OMB has approved the information collection requirements contained in this part under control number 3150-0014.

(b) The approved information collection requirements contained in this part appear in §§ 20.102, 20.103, 20.106, 20.108, 20.203, 20.206, 20.302, 20.311, 20.401, 20.402, 20.403, 20.406, 20.407, 20.408, and 20.409.

(c) This part contains information collection requirements in addition to those approved under the control number specified in paragraph (a) of this section. These information collection requirements and the control numbers under which they are approved are as follows:

- (1) In §§ 20.101 and 20.102, Form NRC-4 is approved under control number 3150-0005.
- (2) In § 20.401, Form NRC-6 is approved under control number 3150-0006.

PERMISSIBLE DOSES, LEVELS, AND CONCENTRATIONS

§ 20.101 Radiation dose standards for individuals in restricted areas.

(a) In accordance with the provisions of § 20.102(a), and except as provided in paragraph (b) of this section, no licensee shall possess, use, or transfer licensed material in such a manner as to

cause any individual in a restricted area to receive in any period of one calendar quarter from radioactive material and other sources of radiation a total occupational dose in excess of the standards specified in the following table:

REMS PER CALENDAR QUARTER

1. Whole body head and trunk, active blood forming organs, lens of eyes or gonads	14
2. Hands and forearms, feet and ankles	184
3. Skin of whole body	74

(b) A licensee may permit an individual in a restricted area to receive a total occupational dose to the whole body greater than that permitted under paragraph (a) of this section, provided:

(1) During any calendar quarter the total occupational dose to the whole body shall not exceed 3 rems; and

(2) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5 (N-18) rems where "N" equals the individual's age in years at his last birthday; and

(3) The licensee has determined the individual's accumulated occupational dose to the whole body on Form NRC-4, or on a clear and legible record containing all the information required in that form; and has otherwise complied with the requirements of § 20.102. As used in paragraph (b), "Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye.

§ 20.102 Determination of prior dose.

(a) Each licensee shall require any individual, prior to first entry of the individual in the licensee's restricted area during each employment or work assignment under such circumstances that the individual will receive or is likely to receive in any period of one calendar quarter an occupational dose in excess of 25 percent of the applicable standards specified in § 20.101(a) and § 20.104(a), to disclose in a written, signed statement, either: (1) That the individual had no prior occupational dose during the current calendar quarter; or (2) the nature and amount of any occupational dose which the individual may have received during that specifically identified current calendar quarter from sources of radiation possessed or controlled by other persons. Each licensee shall maintain records of such statements until the Commission authorizes their disposition.

(b) Before permitting, pursuant to § 20.101(b), any individual in a restricted area to receive an occupational radiation dose in excess of the standards specified in § 20.101(a), each licensee shall:

(1) Obtain a certificate on Form NRC-4, or on a clear and legible record containing all the information required in that form, signed by the individual showing each period of time after the individual attained the age of 18 in which the individual received an occupational dose of radiation; and

(2) Calculate on Form NRC-4 in accordance with the instructions appearing therein, or on a clear and legible record containing all the information required in that form, the previously accumulated occupational dose received by the individual and the additional dose allowed for that individual under § 20.101(b).

(c)(1) In the preparation of Form NRC-4, or a clear and legible record containing all the information required in that form, the licensee shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. For each period for which the licensee obtains

such reports, the licensee shall use the dose shown in the report in preparing the form. In any case where a licensee is unable to obtain reports of the individual's occupational dose for a previous complete calendar quarter, it shall be assumed that the individual has received the occupational dose specified in whichever of the following columns apply:

Part of body	Column 1— Assumed exposure in rems for calendar quarters prior to Jan. 1, 1961	Column 2— Assumed exposure in rems for calendar quarters beginning on or after Jan. 1, 1961
Whole body, gonads, active blood-forming organs, head and trunk, lens of eye	24	14

(2) The licensee shall retain and preserve records used in preparing Form NRC-4 until the Commission authorizes their disposition.

If calculation of the individual's accumulated occupational dose for all periods prior to January 1, 1961 yields a result higher than the applicable accumulated dose value for the individual as of that date, as specified in paragraph (b) of § 20.101, the excess may be disregarded.

§ 20.103 Exposure of individuals to concentrations of radioactive materials in air in restricted areas.

(a)(1) No licensee shall possess, use, or transfer licensed material in such a manner as to permit any individual in a restricted area to inhale a quantity of radioactive material in any period of one calendar quarter greater than the quantity which would result from inhalation for 40 hours per week for 13 weeks at uniform concentrations of radioactive material in air specified in Appendix B, Table I, Column 1. (2) If

the radioactive material is of such form that intake by absorption through the skin is likely, individual exposures to radioactive material shall be controlled so that the uptake of radioactive material by any organ from either inhalation or absorption or both routes of intake "in any calendar quarter does not exceed that which would result from inhaling such radioactive material for 40 hours per week for 13 weeks at uniform concentrations specified in Appendix B, Table I, Column 1.

(2) No licensee shall possess, use, or transfer mixtures of U-234, U-235, and U-238 in soluble form in such a

manner as to permit any individual in a restricted area to inhale a quantity of such material in excess of the intake limits specified in Appendix B, Table I, Column 1 of this part. If such soluble uranium is of a form such that absorption through the skin is likely, individual exposures to such material shall be controlled so that the uptake of such material by any organ from

either inhalation or absorption or both routes of intake "does not exceed that which would result from inhaling such material at the limits specified in Appendix B, Table I, Column 1 and footnote 4 thereto.

(3) For purposes of determining compliance with the requirements of this section the licensee shall use suitable measurements of concentrations of radioactive materials in air for detecting and evaluating airborne radioactivity in restricted areas and in addition, as appropriate, shall use measurements of radioactivity in the body, measurements of radioactivity excreted from the body, or any combination of such measurements as may be necessary for timely detection and assessment of individual intakes of radioactivity by exposed individuals. It is assumed that an individual inhales radioactive material at the airborne concentration in which he is present unless he uses respiratory protective equipment pursuant to paragraph (c) of this section. When assessment of a particular individual's intake of radioactive material is necessary, intakes less than those which would result from inhalation for 2 hours in any one day or for 10 hours in any one week at uniform concentrations specified in Appendix B, Table I, Column 1 need not be included in such assessment, provided that for any assessment in excess of these amounts the entire amount is included.

(b)(1) The licensee shall, as a precautionary procedure, use process or other engineering controls, to the extent practicable, to limit concentrations of radioactive materials in air to levels below those which delimit an airborne radioactivity area as defined in § 20.203(d)(1)(ii).

(2) When it is impracticable to apply process or other engineering controls to limit concentrations of radioactive material in air below those defined in § 20.203(d)(1)(ii), other precautionary procedures, such as increased surveillance, limitation of working times, or provision of respiratory protective equipment, shall be used to maintain intake of radioactive material by any individual within any period of seven consecutive days as far below that intake of radioactive material which

would result from inhalation of such material for 40 hours at the uniform concentrations specified in Appendix B, Table I, Column 1 as is reasonably achievable. Whenever the intake of radioactive material by any individual exceeds this 40-hour control measure, the licensee shall make such evaluations and take such actions as are necessary to assure against recurrence. The licensee shall maintain records of such occurrences, evaluations, and actions taken in a clear and readily identifiable form suitable for summary review and evaluation.

(c) When respiratory protective equipment is used to limit the inhalation of airborne radioactive material pursuant to paragraph (b)(2) of this section, the licensee shall use equipment that is certified or had certification extended by the National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA). The licensee may make allowance for this use of respiratory protective equipment in estimating exposures of individuals to this material provided that:

"Since the concentration specified for tritium oxide vapor assumes equal intakes by skin absorption and inhalation, the total intake permitted is twice that which would result from inhalation alone at the concentration specified for H-3 in Appendix B, Table I, Column 1 for 40 hours per week for 13 weeks.

"For radon-222, the limiting quantity is that inhaled in a period of one calendar year. For radioactive materials designated "Sub" in the "Isotope" column of the table, the concentration value specified is based upon exposure to the material as an external radiation source. Individual exposures to these materials may be accounted for as part of the limitation on individual dose in § 20.101. These nuclides shall be subject to the precautionary procedures required by § 20.103(b)(1).

"Multiply the concentration values specified in Appendix B, Table I, Column 1, by 6.3×10^4 ml to obtain the quarterly quantity limit. Multiply the concentration value specified in Appendix B, Table I, Column 1, by 2.5×10^4 ml to obtain the annual quantity limit for Rn-222.

"Significant intake by ingestion or injection is presumed to occur only as a result of circumstances such as accident, inadvertence, poor procedure, or similar special conditions. Such intakes must be evaluated and accounted for by techniques and procedures as may be appropriate to the circumstances of the occurrence. Exposures so evaluated shall be included in determining whether the limitation on individual exposures in § 20.103(a)(1) has been exceeded.

"Regulatory guidance on assessment of individual intakes of radioactive material is given in Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations and Assumptions for a Bioassay Program," single copies of which are available from the Office of Standards Development, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, upon written request.

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(1) The licensee selects respiratory protective equipment that provides a protection factor greater than the multiple by which peak concentrations of airborne radioactive materials in the working area are expected to exceed the values specified in Appendix B, Table I, Column 1 of this part. The equipment so selected shall be used so that the average concentration of radioactive material in the air that is inhaled during any period of uninterrupted use in an airborne radioactivity area, on any day, by any individual using the equipment, does not exceed the values specified in Appendix B, Table I, Column 1 of this part. For the purposes of this paragraph, the concentration of radioactive material in the air that is inhaled when respirators are worn may be estimated by dividing the ambient concentration in air by the protection factor specified in Appendix A of this part. If the exposure is later found to be greater than estimated, the corrected value shall be used. If the exposure is later found to be less than estimated, the corrected value may be used.

(2) The licensee maintains and implements a respiratory protection program that includes, as a minimum: air sampling sufficient to identify the hazard; permit proper equipment selection and estimate exposures; surveys and bioassays as appropriate to evaluate actual exposures; written procedures regarding selection, fitting, and maintenance of respirators; and testing of respirators for operability immediately prior to each use; written procedures regarding supervision and training of personnel and issuance records; and determination by a physician prior to initial use of respirators, and at least every 12 months thereafter, that the individual user is physically able to use the respiratory protective equipment.

(3) A written policy statement on respirator usage shall be issued covering such things as: use of practicable engineering controls instead of respirators; routine, nonroutine, and emergency use of respirators; and periods of respirator use and relief from respirator use. The licensee shall advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other condition that might require such relief.

(4) The licensee uses equipment within limitations for type and mode of use and provides proper visual, communication, and other special capabilities (such as adequate skin protection) when needed.

(d) Unless otherwise authorized by the Commission, the licensee shall not assign protection factors in excess of

those specified in Appendix A of this part in selecting and using respiratory protective equipment. The Commission may authorize a licensee to use higher protection factors on receipt of an application (1) describing the situation for which a need exists for higher protection factors, and (2) demonstrating that the respiratory protective equipment will provide these higher protection factors under the proposed conditions of use.

(e) Where equipment of a particular type has not been tested and certified, or had certification extended, by NIOSH/MSHA, or where there is no existing schedule for test and certification of certain equipment, the licensee shall not make allowance for this equipment without specific authorization by the Commission. An application for this authorization must include a demonstration by testing, or on the basis of reliable test information, that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use.

(f) Only equipment that has been specifically certified or had certification extended for emergency use by NIOSH/MSHA shall be used as emergency devices.

(g) The licensee shall notify, in writing, the Director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office listed in Appendix D at least 30 days before the date that respiratory protective equipment is first used under the provisions of this section.

§ 20.104 Exposure of minors.

(a) No licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual within a restricted area who is under 18 years of age, to receive in any period of one calendar quarter from radioactive material and other sources of radiation in the licensee's possession a dose in excess of 10 percent of the limits specified in the table in paragraph (a) of § 20.101.

(b) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual within a restricted area, who is under 18 years of age to be exposed to airborne radioactive material possessed by the licensee in an average concentration in excess of the limits specified in Appendix B, Table II of this part. For purposes of this paragraph, concentrations may be averaged over periods not greater than a week.

(c) The provisions of §§ 20.103(b)(2) and 20.103(c) shall apply to exposures subject to paragraph (b) of this section except that the references in §§ 20.103(b)(2) and 20.103(c) to Appendix B, Table I, Column 1 shall be deemed to be references to Appendix B, Table II, Column 1.

§ 20.105 Permissible levels of radiation in unrestricted areas.

(a) There may be included in any application for a license or for amendment of a license proposed limits upon levels of radiation in unrestricted areas resulting from the applicant's possession or use of radioactive material and other sources of radiation. Such applications should include information as to anticipated average radiation levels and anticipated occupancy times for each unrestricted area involved. The Commission will approve the proposed limits if the applicant demonstrates that the proposed limits are not likely to cause any individual to receive a dose to the whole body in any period of one calendar year in excess of 0.5 rem.

(b) Except as authorized by the Commission pursuant to paragraph (a) of this section, no licensee shall possess, use or transfer licensed material in such a manner as to create in any unrestricted area from radioactive material and other sources of radiation in his possession:

(1) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of two millirems in any one hour; or

(2) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 100 millirems in any seven consecutive days.

(c) In addition to other requirements of this part, licensees engaged in uranium fuel cycle operations subject to the provisions of 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," shall comply with that part.

§ 20.106 Radioactivity in effluents to unrestricted areas.

(a) A licensee shall not possess, use, or transfer licensed material so as to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix B, Table II of this part, except as authorized pursuant to § 20.302 or paragraph (b) of this section. For purposes of this section concentrations may be averaged over a period not greater than one year.

(b) An application for a license or amendment may include proposed limits higher than those specified in paragraph (a) of this section. The Commission will approve the proposed limits if the applicant demonstrates:

(1) That the applicant has made a reasonable effort to minimize the radioactivity contained in effluents to unrestricted areas; and

(2) That it is not likely that radioactive material discharged in the effluent would result in the exposure of an individual to concentrations of radioactive material in air or water exceeding the limits specified in Appendix B, Table II of this part.

(c) An application for higher limits pursuant to paragraph (b) of this section shall include information demonstrating that the applicant has made a reasonable effort to minimize the radioactivity discharged in effluents to unrestricted areas, and shall include, as pertinent:

(1) Information as to flow rates, total volume of effluent, peak concentration of each radionuclide in the effluent, and concentration of each radionuclide in the effluent averaged over a period of one year at the point where the effluent leaves a stack, tube, pipe, or similar conduit;

(2) A description of the properties of the effluents, including:

(i) Chemical composition;

(ii) Physical characteristics, including suspended solids content in liquid effluents, and nature of gas or aerosol for air effluents;

(iii) The hydrogen ion concentrations (pH) of liquid effluents; and

(iv) The size range of particulates in effluents released into air.

(3) A description of the anticipated human occupancy in the unrestricted area where the highest concentration of radioactive material from the effluent is expected, and, in the case of a river or stream, a description of water uses downstream from the point of release of the effluent.

(4) Information as to the highest concentration of each radionuclide in an unrestricted area, including anticipated concentrations averaged over a period of one year:

(i) In air at any point of human occupancy; or

(ii) In water at points of use downstream from the point of release of the effluent.

(5) The background concentration of radionuclides in the receiving river or stream prior to the release of liquid effluent.

(6) A description of the environmental monitoring equipment, including sensitivity of the system, and procedures and calculations to determine concentrations of radionuclides in the unrestricted area and possible recon-

centrations of radionuclides.

(7) A description of the waste treatment facilities and procedures used to reduce the concentration of radionuclides in effluents prior to their release.

(d) For the purposes of this section the concentration limits in Appendix B, Table II of this part shall apply at the boundary of the restricted area. The concentration of radioactive material discharged through a stack, pipe or similar conduit may be determined with respect to the point where the material leaves the conduit. If the conduit discharges within the restricted area, the concentration at the boundary may be determined by applying appropriate factors for dilution, dispersion, or decay between the point of discharge and the boundary.

(e) In addition to limiting concentrations in effluent streams, the Commission may limit quantities of radioactive materials released in air or water during a specified period of time if it appears that the daily intake of radioactive material from air, water, or food by a suitable sample of an exposed population group, averaged over a period not exceeding one year, would otherwise exceed the daily intake resulting from continuous exposure to air or water containing one-third the concentration of radioactive materials specified in Appendix B, Table II of this part.

(f) The provisions of paragraphs (a) through (e) of this section do not apply to disposal of radioactive material into sanitary sewerage systems, which is governed by § 20.303.

(g) In addition to other requirements of this part, licensees engaged in uranium fuel cycle operations subject to the provisions of 40 CFR Part 190, "Environmental Radiation Protection Standard for Nuclear Power Operations," shall comply with that part.

§ 20.107 Medical diagnosis and therapy.

Nothing in the regulations in this part shall be interpreted as limiting the intentional exposure of patients to radiation for the purpose of medical diagnosis or medical therapy.

§ 20.108 Orders requiring furnishing of bio-assay services.

Where necessary or desirable in order to aid in determining the extent of an individual's exposure to concentrations of radioactive material, the Commission may incorporate appropriate provisions in any license, directing the licensee to make available to the individual appropriate bio-assay services and to furnish a copy of the reports of such services to the Commission.

PRECAUTIONARY PROCEDURES

§ 20.201 Surveys.

(a) As used in the regulations in this part, "survey" means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.

(b) Each licensee shall make or cause to be made such surveys as (1) may be necessary for the licensee to comply with the regulations in this part, and (2) are reasonable under the circumstances to evaluate the extent of radiation hazards that may be present.

§ 20.202 Personnel monitoring.

(a) Each licensee shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

(1) Each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 25 percent of the applicable value specified in paragraph (a) of § 20.101.

(2) Each individual under 18 years of age who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 5 percent of the applicable value specified in paragraph (a) of § 20.101.

(3) Each individual who enters a high radiation area.

(b) As used in this part,

(1) "Personnel monitoring equipment" means devices designed to be worn or carried by an individual for the purpose of measuring the dose received (e.g., film badges, pocket chambers, pocket dosimeters, film rings, etc.);

(2) "Radiation area" means any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem, or in any 5 consecutive days a dose in excess of 100 millirems;

(3) "High radiation area" means any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

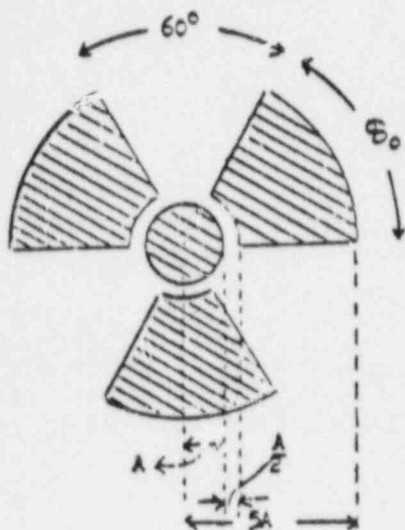
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§ 20.203 Caution signs, labels, signals and controls.

(a) General. (1) Except as otherwise authorized by the Commission, symbols prescribed by this section shall use the conventional radiation caution colors (magenta or purple on yellow background). The symbol prescribed by this section is the conventional three-bladed design:

RADIATION SYMBOL

1. Cross-hatched area is to be magenta or purple.
2. Background is to be yellow.



(2) In addition to the contents of signs and labels prescribed in this section, licensees may provide on or near such signs and labels any additional information which may be appropriate in aiding individuals to minimize exposure to radiation or to radioactive material.

(b) Radiation areas. Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION¹

RADIATION AREA

(c) High radiation areas. (1) Each high radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION¹

HIGH RADIATION AREA

¹Or "Danger".

(2) Each entrance or access point to a high radiation area shall be:

(i) Equipped with a control device which shall cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirems in 1 hour upon entry into the area; or

(ii) Equipped with a control device which shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering the high radiation area and the licensee or a supervisor of the activity are made aware of the entry; or

(iii) Maintained locked except during periods when access to the area is required, with positive control over each individual entry.

(3) The controls required by paragraph (c)(2) of this section shall be established in such a way that no individual will be prevented from leaving a high radiation area.

(4) In the case of a high radiation area established for a period of 30 days or less, direct surveillance to prevent unauthorized entry may be substituted for the controls required by paragraph (c)(2) of this section.

(5) Any licensee, or applicant for a license, may apply to the Commission for approval of methods not included in paragraphs (c)(2) and (4) of this section for controlling access to high radiation areas. The Commission will approve the proposed alternatives if the licensee or applicant demonstrates that the alternative methods of control will prevent unauthorized entry into a high radiation area, and that the requirement of paragraph (c)(3) of this section is met.

(6) Each area in which there may exist radiation levels in excess of 500 rems in one hour at one meter from a sealed radioactive source² that is used to irradiate materials shall:

(i) Have each entrance or access point equipped with entry control devices which shall function automatically to prevent any individual from inadvertently entering the area when such radiation levels exist; permit deliberate entry into the area only after a control device is actuated that shall cause the radiation level within the area, from the sealed source, to be reduced below that at which it would be possible for an individual to receive a dose in excess of 100 mrem in one hour; and prevent operation of the source if the source would produce radiation levels in the area that could result in a dose to an individual in excess of 100 mrem in one hour. The entry control devices required by this paragraph (c)(6) shall be established in such a way that no individual will be prevented from leaving the area.

(ii) Be equipped with additional control devices such that upon failure of the entry control devices to function as required by paragraph (c)(6)(i) of this section the radiation level within the area, from the sealed source, shall be reduced below that at which it would be possible for an individual to receive a dose in excess of 100 mrem in one hour; and visible and audible alarm signals shall be generated to make an individual attempting to enter the area aware of the hazard and the licensee or at least one other individual, who is familiar with the activity and prepared to render or summon assistance, aware of such failure of the entry control devices.

(iii) Be equipped with control devices such that upon failure or removal of physical radiation barriers other than the source's shielded storage container the radiation level from the source shall be reduced below that at which it would be possible for an individual to receive a dose in excess of 100 mrem in one hour; and visible and audible alarm signals shall be generated to make potentially affected individuals aware of the hazard and the licensee or at least one other individual, who is familiar with the activity and prepared to render or summon assistance, aware of the failure or removal of the physical barrier. When the shield for the stored source is a liquid, means shall be provided to monitor the integrity of the shield and to signal, automatically, loss of adequate shielding. Physical radiation barriers that com-

²This paragraph (c)(6) does not apply to radioactive sources that are used in teletherapy, in radiography, or in completely self-shielded irradiators in which the source is both stored and operated within the same shielding radiation barrier and, in the designed configuration of the irradiator, is always physically inaccessible to any individual and cannot create high levels of radiation in an area that is accessible to any individual. This paragraph (c)(6) also does not apply to sources from which the radiation is incidental to some other use nor to nuclear reactor generated radiation other than radiation from byproduct, source, or special nuclear materials that are used in sealed sources in non-self-shielded irradiators.

³These requirements apply after Mar. 14, 1978. Each person licensed to conduct activities to which this paragraph (c)(6) applies and who is not in compliance with the provisions of this paragraph on Mar. 14, 1978, shall file with the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, on or before June 14, 1978, information describing in detail the actions taken or to be taken to achieve compliance with this paragraph by Dec. 14, 1978, and may continue activities in conformance with present license conditions and the provisions of the previously effective § 20.2034 until such compliance is achieved. For such persons compliance must be achieved not later than Dec. 14, 1978.

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prise permanent structural components, such as walls, that have no credible probability of failure or removal in ordinary circumstances need not meet the requirements of this paragraph (c)(5)(iii).

(iv) Be equipped with devices that will automatically generate visible and audible alarm signals to alert personnel in the area before the source can be put into operation and in sufficient time for any individual in the area to operate a clearly identified control device which shall be installed in the area and which can prevent the source from being put into operation.

(v) Be controlled by use of such administrative procedure and such devices as are necessary to assure that the area is cleared of personnel prior to each use of the source preceding which use it might have been possible for an individual to have entered the area.

(vi) Be checked by a physical radiation measurement to assure that prior to the first individual's entry into the area after any use of the source, the radiation level from the source in the area is below that at which it would be possible for an individual to receive a dose in excess of 100 mrem in one hour.

(vii) Have entry control devices required in paragraph (c)(6)(i) of this section which have been tested for proper functioning prior to initial operation with such source of radiation on any day that operations are not interruptedly continued from the previous day or before resuming operations after any unintended interruption, and for which records are kept of the dates, times, and results of such tests of function. No operations other than those necessary to place the source in safe condition or to effect repairs on controls shall be conducted with such source unless control devices are functioning properly. The licensee shall submit an acceptable schedule for more complete periodic tests of the entry control and warning systems to be established and adhered to as a condition of the license.

(viii) Have those entry and exit portals that are used in transporting materials to and from the irradiation area, and that are not intended for use by individuals controlled by such devices and administrative procedures as are necessary to physically protect and warn against inadvertent entry by any individual through such portals. Exit portals for processed materials shall be equipped to detect and signal the presence of loose radiation sources that are carried toward such an exit and to automatically prevent such loose sources from being carried out of the area.

(7) Licensees with, or applicants for, licenses for radiation sources that are within the purview of paragraph (c)(6) of this section, and that must be used in a variety of positions or in peculiar locations, such as open fields or forests, that make it impracticable to comply with certain requirements of paragraph (c)(6) of this section, such as those for the automatic control of radiation levels, may apply to the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, for approval, prior to use of safety measures that are alternative to those specified in paragraph (c)(6) of this section, and that will provide at least an equivalent degree of personnel protection in the use of such sources. At least one of the alternative measures must include an entry-preventing interlock control based on a physical measurement of radiation that assures the absence of high radiation levels before an individual can gain access to an area where such sources are used.

(d) Airborne radioactivity areas. (1) As used in the regulations in this part "airborne radioactivity area" means (i) any room, enclosure, or operating area in which airborne radioactive materials composed wholly or partly of licensed material, exist in concentrations in excess of the amounts specified in Appendix B, Table I, Column 1 of this part; or (ii) any room, enclosure, or operating area in which airborne radioactive material composed wholly or partly of licensed material exists in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25 percent of the amounts specified in Appendix B Table I, Column 1 of this part.

(2) Each airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION

AIRBORNE RADIOACTIVITY AREA

(e) Additional requirements. (1) Each area or room in which licensed material is used or stored and which contains any radioactive material (other than natural uranium or thorium) in an amount exceeding 10 times the quantity of such material specified in Appendix C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

"Or "Danger".

"As appropriate, the information will include radiation levels, kinds of material, estimate of activity, date for which activity is estimated, mass enrichment, etc.

CAUTION

RADIOACTIVE MATERIAL(S)

(2) Each area or room in which natural uranium or thorium is used or stored in any amount exceeding one hundred times the quantity specified in Appendix C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION

RADIOACTIVE MATERIAL(S)

(f) Containers. (1) Except as provided in paragraph (f)(3) of this section, each container of licensed material shall bear a durable, clearly visible label identifying the radioactive contents.

(2) A label required pursuant to paragraph (f)(1) of this section shall bear the radiation caution symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL". It shall also provide sufficient information to permit individuals handling or using the containers, or working in the vicinity thereof, to take precautions to avoid or minimize exposures.

(3) Notwithstanding the provisions of paragraph (f)(1) of this section labeling is not required:

(i) For containers that do not contain licensed materials in quantities greater than the applicable quantities listed in Appendix C of this part.

(ii) For containers containing only natural uranium or thorium in quantities no greater than 10 times the applicable quantities listed in Appendix C of this part.

(iii) For containers that do not contain licensed materials in concentrations greater than the applicable concentrations listed in Appendix B, Table I, Column 2, of this part.

(iv) For containers when they are attended by an individual who takes the precautions necessary to prevent the exposure of any individual to radiation

or radioactive materials in excess of the limits established by the regulations in this part.

(v) For containers when they are in transport and packaged and labeled in accordance with regulations of the Department of Transportation.

(vi) For containers which are accessible only to individuals authorized to handle or use them, or to work in the vicinity thereof, provided that the contents are identified to such individuals by a readily available written record.

(vii) For manufacturing or process equipment, such as nuclear reactors, reactor components, piping, and tanks.

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(4) Each licensee shall, prior to disposal of an empty uncontaminated container to unrestricted areas, remove or deface the radioactive material label or otherwise clearly indicate that the container no longer contains radioactive materials.

§ 20.204 Same exceptions.

Notwithstanding the provisions of § 20.203,

(a) A room or area is not required to be posted with a caution sign because of the presence of a sealed source provided the radiation level twelve inches from the surface of the source container or housing does not exceed five millirem per hour.

(b) Rooms or other areas in hospitals are not required to be posted with caution signs, and control of entrance or access thereto pursuant to § 20.203(c) is not required, because of the presence of patients containing by-product material provided that there are personnel in attendance who will take the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established in the regulations in this part.

(c) Caution signs are not required to be posted at areas or rooms containing radioactive materials for periods of less than eight hours provided that (1) the materials are constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established in the regulations in this part and; (2) such area or room is subject to the licensee's control.

(d) A room or other area is not required to be posted with a caution sign, and control is not required for each entrance or access point to a room or other area which is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled in accordance with regulations of the Department of Transportation.

§ 20.205 Procedures for picking up, receiving, and opening packages.

(a)(1) Each licensee who expects to receive a package containing quantities of radioactive material in excess of the Type A quantities specified in paragraph (b) of this section shall:

(i) If the package is to be delivered to the licensee's facility by the carrier, make arrangements to receive the package when it is offered for delivery by the carrier; or

(ii) If the package is to be picked up by the licensee at the carrier's terminal, make arrangements to receive notification from the carrier of the arrival of the package, at the time of arrival.

(2) Each licensee who picks up a package of radioactive material from a carrier's terminal shall pick up the package expeditiously upon receipt of notification from the carrier of its arrival.

(b)(1) Each licensee, upon receipt of a package of radioactive material, shall monitor the external surfaces of the package for radioactive contamination caused by leakage of the radioactive contents, except:

(i) Packages containing no more than the exempt quantity specified in the table in this paragraph;

(ii) Packages containing no more than 10 millicuries of radioactive material consisting solely of tritium, carbon-14, sulfur-35, or iodine-125;

(iii) Packages containing only radioactive material as gases or in special form;

(iv) Packages containing only radioactive material in other than liquid form (including Mo-99/Tc-99m generators) and not exceeding the Type A quantity limit specified in the table in this paragraph; and

(v) Packages containing only radionuclides with half-lives of less than 30 days and a total quantity of no more than 100 millicuries.

The monitoring shall be performed as soon as practicable after receipt, but no later than three hours after the package is received at the licensee's facility if received during the licensee's normal working hours, or eighteen hours if received after normal working hours.

(2) If removable radioactive contamination in excess of 0.01 microcuries (22,000 disintegrations per minute) per 100 square centimeters of package surface is found on the external surfaces of the package, the licensee shall immediately notify the final delivering carrier and, by telephone and telegraph, mailgram or facsimile, the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office shown in Appendix D of this part.

TABLE OF EXEMPT AND TYPE A QUANTITIES

Transport group	Exempt quantity mCi (or millicuries)	Type A quantity mCi (or curies)
I	0.1	0.001
II	0.1	0.05C
III	1	3
IV	1	20
V	1	20
VI	1	100C
VII	25,000	1000
Special Form	1	20

¹The definitions of "transport group" and "special form" are specified in § 71.4 of this chapter.

[Footnote 1 removed 49 FR 19623]

(c)(1) Each licensee, upon receipt of a package containing quantities of radioactive material in excess of the Type A quantities specified in paragraph (b) of this section, other than those transported by exclusive use vehicle, shall monitor the radiation levels external to the package. The package shall be monitored as soon as practicable after receipt, but no later than three hours after the package is received at the licensee's facility if received during the licensee's normal working hours, or 18 hours if received after normal working hours.

(2) If radiation levels are found on the external surface of the package in excess of 200 millirem per hour, or at three feet from the external surface of the package in excess of 10 millirem per hour,

the licensee shall immediately notify by telephone and telegraph mailgram, or facsimile, the director of the appropriate NRC Regional Office listed in Appendix D, and the final delivering carrier.

(d) Each licensee shall establish and maintain procedures for safely opening packages in which licensed material is received, and shall assure that such procedures are followed and that due consideration is given to special instructions for the type of package being opened.

§ 20.206 Instruction of personnel.

Instructions required for individuals working in, or frequenting any portion of a restricted area are specified in § 19.12 of this chapter.

§ 20.207 Storage and control of licensed materials in unrestricted areas.

(a) Licensed materials stored in an unrestricted area shall be secured from unauthorized removal from the place of storage.

(b) Licensed materials in an unrestricted area and not in storage shall be

¹For example, containers in locations such as water-filled canals, storage vaults, or hot cells.

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tended under the constant surveillance and immediate control of the licensee.

WASTE DISPOSAL

§ 20.301 General requirement.

No licensee shall dispose of licensed material except:

(a) By transfer to an authorized recipient as provided in the regulations in Parts 30, 40, 60, 61, 70 or 72 of this chapter, whichever may be applicable; or

(b) As authorized under § 20.302 or Part 41 of this chapter; or

(c) As provided in § 20.303, applicable to the disposal of licensed material by release into sanitary sewerage systems, or in § 20.306 for disposal of specific wastes, or in § 20.106 (Radioactivity in effluents to unrestricted areas).

§ 20.302 Method for obtaining approval of proposed disposal procedures.

(a) Any licensee or applicant for a license may apply to the Commission for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations in this chapter. Each application should include a description of the licensed material and any other radioactive material involved, including the quantities and kinds of such material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application should also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics, usage of ground and surface waters in the general area; the nature and location of other potentially affected facilities; and procedures to be observed to minimize the risk of unexpected or hazardous exposures.

(b) The Commission will not approve any application for a license for disposal of licensed material at sea unless the applicant shows that sea disposal offers less harm to man or the environment than other practical alternative methods of disposal.

§ 20.303 Disposal by release into sanitary sewerage systems.

No licensee shall discharge licensed material into a sanitary sewerage system unless:

(a) It is readily soluble or dispersible in water; and

(b) The quantity of any licensed or other radioactive material released into the system by the licensee in any one day does not exceed the larger of paragraphs (b)(1) or (2) of this section.

(1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the licensee, will result in an average concentration equal to the limits specified in Appendix B, Table 1, Column 2 of this part; or

(2) Ten times the quantity of such material specified in Appendix C of this part; and

(c) The quantity of any licensed or other radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee, will not result in an average concentration exceeding the limits specified in Appendix B, Table 1, Column 2 of this part; and

(d) The gross quantity of licensed and other radioactive material, excluding hydrogen-3 and carbon-14, released into the sewerage system by the licensee does not exceed one curie per year. The quantities of hydrogen-3 and carbon-14 released into the sanitary sewerage system may not exceed 5 curies per year for hydrogen-3 and 1 curie per year for carbon-14. Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

§ 20.305 Treatment or disposal by incineration.

No licensee shall treat or dispose of licensed material by incineration, except for materials listed under § 20.306 or as specifically approved by the Commission pursuant to §§ 20.106(b) and 20.302.

§ 20.306 Disposal of specific wastes.

Any licensee may dispose of the following licensed material without regard to its radioactivity:

(a) 0.05 microcuries or less of hydrogen-3 or carbon-14, per gram of medium, used for liquid scintillation counting; and

(b) 0.05 microcuries or less of hydrogen-3 or carbon-14, per gram of animal tissue averaged over the weight of the entire animal; provided however, tissue may not be disposed of under this section in a manner that would permit its use either as food for humans or as animal feed.

(c) Nothing in this section, however, relieves the licensee of maintaining records showing the receipt, transfer and disposal of such byproduct material as specified in § 30.51 of this chapter; and

(d) Nothing in this section relieves the licensee from complying with other applicable Federal, State and local regulations governing any other toxic or hazardous property of these materials.

§ 20.311 Transfer for disposal and manifests.

(a) Purpose. The requirements of this section are designed to control transfers of radioactive waste intended for disposal at a land disposal facility and establish a manifest tracking system and supplement existing requirements concerning transfers and recordkeeping for such wastes. The reporting and recordkeeping requirements contained in this section have been approved by the Office of Management and Budget OMB approval No. 3150-0014.

(b) Each shipment of radioactive waste to a licensed land disposal facility must be accompanied by a shipment manifest that contains the name, address, and telephone number of the person generating the waste. The manifest shall also include the name, address, and telephone number or the name and EPA hazardous waste identification number of the person transporting the waste to the land disposal facility. The manifest must also indicate as completely as practicable: a physical description of the waste; the volume; radionuclide identity and quantity; the total radioactivity; and the principal chemical form. The solidification agent must be specified. Waste containing more than 0.1% chelating agents by weight must be identified and the weight percentage of the chelating agent estimated. Wastes classified as Class A, Class B, or Class C in § 61.55 of this chapter must be clearly identified as such in the manifest. The total quantity of the radionuclides H-3, C-14, Tc-99 and I-129 must be shown. The manifest required by this paragraph may be shipping papers used to meet Department of Transportation or

Environmental Protection Agency regulations or requirements of the receiver, provided all the required information is included. Copies of manifests required by this section may be legible carbon copies or legible photocopies.

(c) Each manifest must include a certification by the waste generator that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation and the Commission. An authorized representative of the waste generator shall sign and date the manifest.

(d) Any generating licensee who transfers radioactive waste to a land disposal facility or a licensed waste collector shall comply with the requirements in paragraphs (d)(1) through (8) of this section. Any generating licensee who transfers waste to a licensed waste processor who treats or repackages waste shall comply with the requirements of paragraphs (d)(4) through (8) of this section. A licensee shall:

(1) Prepare all wastes so that the waste is classified according to § 61.55 and meets the waste characteristics requirements in § 61.56 of this chapter;

(2) Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with § 61.55 of this chapter;

(3) Conduct a quality control program to assure compliance with §§ 61.55 and 61.56 of this chapter; the program must include management evaluation of audits;

(4) Prepare shipping manifests to meet the requirements of §§ 20.311 (b) and (c) of this part;

(5) Forward a copy of the manifest to the intended recipient, at the time of shipment or, deliver to a collector at the time the waste is collected, obtaining acknowledgement of receipt in the form of a signed copy of the manifest or equivalent documentation from the collector;

(6) Include one copy of the manifest with the shipment;

(7) Retain a copy of the manifest and documentation of acknowledgement of receipt as the record of transfer of licensed material as required by Parts 30, 40, and 70 of this chapter; and,

(8) For any shipments or any part of a shipment for which acknowledgement of receipt has not been received within the times set forth in this section, conduct an investigation in accordance with paragraph (h) of this section.

(e) Any waste collector licensee who handles only prepackaged waste shall:

(1) Acknowledge receipt of the waste from the generator within one week of receipt by returning a signed copy of the manifest or equivalent documentation;

(2) Prepare a new manifest to reflect consolidated shipments; the new manifest shall serve as a listing or index for the detailed generator manifests. Copies of the generator manifests shall be a part of the new manifest. The waste collector may prepare a new manifest without attaching the generator manifests, provided the new manifest contains for each package the information specified in paragraph (b) of this section. The collector licensee shall certify that nothing has been done to the waste which would invalidate the generator's certification;

(3) Forward a copy of the new manifest to the land disposal facility operator at the time of shipment;

(4) Include the new manifest with the shipment to the disposal site;

(5) Retain a copy of the manifest and documentation of acknowledgement of receipt as the record of transfer of licensed material as required by Parts 30, 40, and 70 of this chapter, and retain information from generator manifests until disposition is authorized by the Commission; and,

(6) For any shipments or any part of a shipment for which acknowledgement of receipt is not received within the times set forth in this section, conduct an investigation in accordance with paragraph (h) of this section.

(f) Any licensed waste processor who treats or repackages wastes shall:

(1) Acknowledge receipt of the waste from the generator within one week of receipt by returning a signed copy of the manifest or equivalent documentation;

(2) Prepare a new manifest that meets the requirements of paragraphs (b) and (c) of this section. Preparation of the new manifest reflects that the processor is responsible for the waste;

(3) Prepare all wastes so that the waste is classified according to § 61.55 and meets the waste characteristics requirements in § 61.56 of this chapter;

(4) Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with §§ 61.55 and 61.57 of this chapter;

(5) Conduct a quality control program to assure compliance with §§ 61.55 and 61.56 of this chapter. The program shall include management evaluation of audits;

(6) Forward a copy of the new manifest to the disposal site operator or waste collector at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgement of receipt in the form of a signed copy of the manifest or

equivalent documentation by the collector;

(7) Include the new manifest with the shipment;

(8) Retain copies of original manifests and new manifests and documentation of acknowledgement of receipt as the record of transfer of licensed material required by Parts 30, 40, and 70 of this chapter; and

(9) For any shipment or part of a shipment for which acknowledgement is not received within the times set forth in this section, conduct an investigation in accordance with paragraph (h) of this section.

(g) The land disposal facility operator shall:

(1) Acknowledge receipt of the waste within one week of receipt by returning a signed copy of the manifest or equivalent documentation to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. The returned copy of the manifest or equivalent documentation shall indicate any discrepancies between materials listed on the manifest and materials received;

(2) Maintain copies of all completed manifests or equivalent documentation until the Commission authorizes their disposition; and

(3) Notify the shipper (i.e., the generator, the collector, or processor) and the Director of the nearest Commission Regional Office listed in Appendix D of this part when any shipment or part of a shipment has not arrived within 60 days after the advance manifest was received.

(b) Any shipment or part of a shipment for which acknowledgement is not received within the times set forth in this section, must:

(1) Be investigated by the shipper if the shipper has not received notification of receipt within 20 days after transfer, and

(2) Be traced and reported. The investigation shall include tracing the shipment and filing a report with the nearest Commission Regional Office listed in Appendix D of this part. Each licensee who conducts a trace investigation shall file a written report with the nearest Commission's Regional office within 2 weeks of completion of the investigation.

§ 20.401 Records of surveys, radiation monitoring, and disposal.

(a) Each licensee shall maintain records showing the radiation exposures of all individuals for whom personnel monitoring is required under § 20.202 of the regulations in this part. Such records shall be kept on Form NRC-5, in accordance with the instructions contained in that form or on clear and legible records containing all the information required by Form NRC-5. The doses entered on the forms or records shall be for periods of time not exceeding one calendar quarter.

(b) Each licensee shall maintain records in the same units used in this part, showing the results of surveys required by § 20.201(b), monitoring required by §§ 20.205(b) and 20.205(c), and disposals made under §§ 20.302, 20.303, removed § 20.304, and Part 61 of this chapter.

(c)(1) Records of individual exposure to radiation and to radioactive material which must be maintained pursuant to the provisions of paragraph (a) of this section and records of bioassays, including results of whole body counting examinations, made pursuant to § 20.108, shall be preserved until the Commission authorizes disposition.

(2) Records of the results of surveys and monitoring which must be maintained pursuant to paragraph (b) of this section shall be preserved for two years after completion of the survey except that the following records shall be maintained until the Commission authorizes their disposition: (i) Records of the results of surveys to determine compliance with § 20.103(a); (ii) in the absence of personnel monitoring data, records of the results of surveys to determine external radiation dose; and (iii) records of the results of surveys used to evaluate the release of radioactive effluents to the environment.

(3) Records of disposal of licensed materials made pursuant to §§ 20.302, 20.303, removed § 20.304, and Part 81 of this chapter are to be maintained until the Commission authorizes their disposition.

(4) Records which must be maintained pursuant to this part may be the original or a reproduced copy or microform if such reproduced copy or microform is duly authenticated by authorized personnel and the microform is capable of producing a clear and legible copy after storage for the period specified by Commission regulations.

(5) If there is a conflict between the Commission's regulations in this part, license condition, or technical specification, or other written Commission approval or authorization pertaining to the retention period for the same type of record, the retention period specified in the regulations in this part for such records shall apply unless the Commission pursuant to § 20.501, has granted a specific exemption from the record retention requirements specified in the regulations in this part.

§ 20.402 Reports of theft or loss of licensed material.

(a)(1) Each licensee shall report to the Commission, by telephone, immediately after it determines that a loss or theft of licensed material has occurred in such quantities and under such circumstances that it appears to the licensee that a substantial hazard may result to persons in unrestricted areas.

(2) Reports must be made as follows:

(i) Licensees having an installed Emergency Notification System shall make the reports to the NRC Operations Center in accordance with § 50.72 of this chapter.

(ii) All other licensees shall make reports to the Administrator of the appropriate NRC Regional Office listed in Appendix D of this part.

(b) Each licensee who makes a report under paragraph (a) of this section shall, within 30 days after learning of the loss or theft, make a report in writing to the U.S. Nuclear Regulatory Commission, Document Control Desk, Washington, D.C. 20555, with a copy to the appropriate NRC Regional Office listed in Appendix D of this part. The report shall include the following information:

(1) A description of the licensed material involved, including kind, quantity, chemical, and physical form;

(2) A description of the circumstances under which the loss or theft occurred;

(3) A statement of disposition or probable disposition of the licensed material involved;

(4) Radiation exposures to individ-

uals, circumstances under which the exposures occurred, and the extent of possible hazard to persons in unrestricted areas;

(5) Actions which have been taken, or will be taken, to recover the material; and

(6) Procedures or measures which have been or will be adopted to prevent a recurrence of the loss or theft of licensed material.

(c) Subsequent to filing the written report the licensee shall also report any substantive additional information on the loss or theft which becomes available to the licensee, within 30 days after he learns of such information.

(d) Any report filed with the Commission pursuant to this section shall be so prepared that names of individuals who may have received exposure to radiation are stated in a separate part of the report.

(e) For holders of an operating license for a nuclear power plant, the events included in paragraph (b) of this section must be reported in accordance with the procedures described in § 50.73 (b), (c), (d), (e), and (g) of this chapter and must include the information required in paragraph (b) of this section. Events reported in accordance with § 50.73 of this chapter need not be reported by a duplicate report under paragraph (b) of this section.

§ 20.403 Notifications of incidents.

(a) *Immediate notification.* Each licensee shall immediately report any events involving byproduct, source, or special nuclear material possessed by the licensee that may have caused or threatens to cause:

(1) Exposure of the whole body of any individual to 25 rems or more of radiation; exposure of the skin of the whole body of any individual of 150 rems or more of radiation; or exposure of the feet, ankles, hands or forearms of any individual to 375 rems or more of radiation; or

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Appendix B, Table II of this part; or

(3) A loss of one working week or more of the operation of any facilities affected; or

(4) Damage to property in excess of \$200,000.

(b) *Twenty-four hour notification.*

Each licensee shall within 24 hours of discovery of the event, report any event involving licensed material possessed by the licensee that may have caused or threatens to cause:

(1) Exposure of the whole body of any individual to 5 rems or more of radiation; exposure of the skin of the whole body of any individual to 30 rems or more of radiation; or exposure of the feet, ankles, hands, or forearms to 75 rems or more of radiation; or

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limits specified for such materials in Appendix B, Table II of this part; or

(3) A loss of one day or more of the operation of any facilities affected; or

(4) Damage to property in excess of \$2,000.

(c) Any report filed with the Commission pursuant to this section shall be prepared so that names of individuals who have received exposure to radiation will be stated in a separate part of the report.

(d) Reports made by licensees in response to the requirements of this section must be made as follows:

(i) Licensees that have an installed Emergency Notification System shall make the reports required by paragraphs (a) and (b) of this section to the NRC Operations Center in accordance with § 50.72 of this chapter.

(2) All other licensees shall make the reports required by paragraphs (a) and (b) of this section by telephone and by telegram, mailgram, or facsimile to the Administrator of the appropriate NRC Regional Office listed in Appendix D of this part.

§ 20.404 (Reserved)

§ 20.405 Reports of overexposures and excessive levels and concentrations.

(a)(1) In addition to any notification required by § 20.403 of this part, each licensee shall make a report in writing concerning any one of the following types of incidents within 30 days of its occurrence:

(i) Each exposure of an individual to radiation in excess of the applicable limits in §§ 20.101 or 20.104(a) of this part, or the license;

(ii) Each exposure of an individual to radioactive material in excess of the applicable limits in §§ 20.103(a)(1), 20.103(a)(2), or 20.104(b) of this part, or in the license;

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(iii) Levels of radiation or concentrations of radioactive material in a restricted area in excess of any other applicable limit in the license;

(iv) Any incident for which notification is required by § 20.403 of this part; or

(v) Levels of radiation or concentrations of radioactive material (whether or not involving excessive exposure of any individual) in an unrestricted area in excess of ten times any applicable limit set forth in this part or in the license.

(2) Each report required under paragraph (a)(1) of this section must describe the extent of exposure of individuals to radiation or to radioactive material, including:

(i) Estimates of each individual's exposure as required by paragraph (b) of this section;

(ii) Levels of radiation and concentrations of radioactive material involved;

(iii) The cause of the exposure, levels or concentrations; and

(iv) Corrective steps taken or planned to prevent a recurrence.

(b) Any report filed with the Commission pursuant to paragraph (a) of this section shall include for each individual exposed the name, social security number, and date of birth, and an estimate of the individual's exposure. The report shall be prepared so that this information is stated in a separate part of the report.

(c)(1) In addition to any notification required by § 20.403 of this part, each licensee shall make a report in writing of levels of radiation or releases of radioactive material in excess of limits specified by 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," or in excess of license conditions related to compliance with 40 CFR Part 190.

(2) Each report submitted under paragraph (c)(1) of this section must describe:

(i) The extent of exposure of individuals to radiation or to radioactive material;

(ii) Levels of radiation and concentrations of radioactive material involved;

(iii) The cause of the exposure, levels, or concentrations; and

(iv) Corrective steps taken or planned to assure against a recurrence, including the schedule for achieving conformance with 40 CFR Part 190 and with associated license conditions.

(d) For holders of an operating license for a nuclear power plant, the incidents included in paragraphs (a) or (c) of this section must be reported in accordance

with the procedures described in paragraphs 50.73 (b), (c), (d), (e), and (g) of this chapter and must also include the information required by paragraphs (a) and (c) of this section. Incidents reported in accordance with § 50.73 of this chapter need not be reported by a duplicate report under paragraphs (a) or (c) of this section.

(e) All other licensees who make reports under paragraphs (a) or (c) of this section shall, within 30 days after learning of the overexposure or excessive level or concentration, make a report in writing to the U.S. Nuclear Regulatory Commission, Document Control Desk, Washington, D.C. 20555, with a copy to the appropriate NRC Regional Office listed in Appendix D of this part.

§ 20.406 [Reserved]

§ 20.407 Personnel monitoring reports.

Each person described in § 20.408 of this part shall, within the first quarter of each calendar year, submit to the Director, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555, the reports specified in paragraphs (a) and (b) of this section, covering the preceding calendar year.¹

(a) A report of either (1) the total number of individuals for whom personnel monitoring was required under § 20.202(a) or § 34.33(a) of this chapter during the calendar year; or (2) the total number of individuals for whom personnel monitoring was provided during the calendar year. Provided, however, That such total includes at least the number of individuals required to be reported under paragraph (a)(1) of this section. The report shall indicate whether it is submitted in accordance with paragraph (a)(1) or (a)(2) of this section. If personnel monitoring was not required to be provided to any individual by the licensee under §§ 20.202(a) or 34.33(a) of this chapter during the calendar year, the licensee shall submit a negative report indicating that such personnel monitoring was not required.

(b) A statistical summary report of the personnel monitoring information recorded by the licensee for individuals for whom personnel monitoring was either required or provided, as described in paragraph (a) of this section, indicating the number of individuals whose total whole body exposure recorded during the previous calendar

¹ A licensee whose license expires or terminates prior to, or on the last day of the calendar year, shall submit reports at the expiration or termination of the license, covering that part of the year during which the license was in effect.

year was in each of the following estimated exposure ranges:

Estimated whole body exposure range (rem)	Number of individuals in each range
No measurable exposure	
Measurable exposure less than 0.1	
0.1 to 0.25	
0.25 to 0.5	
0.5 to 0.75	
0.75 to 1	
1 to 2	
2 to 3	
3 to 4	
4 to 5	
5 to 6	
6 to 7	
7 to 8	
8 to 9	
9 to 10	
10 to 11	
11 to 12	
12+	

Individual values exactly equal to the values separating exposure ranges shall be reported in the higher range.

The low exposure range data are required in order to obtain better information about the exposures actually recorded. This section does not require improved measurements.

§ 20.408 Reports of personnel monitoring on termination of employment or work.

(a) This section applies to each person licensed by the Commission to:

(1) Operate a nuclear reactor designed to produce electrical or heat energy pursuant to § 50.21(b) or § 50.22 of this chapter or a testing facility as defined in § 50.2 of this chapter.

(2) Possess or use byproduct material for purposes of radiography pursuant to Parts 30 and 34 of this chapter;

(3) Possess or use at any one time, for purposes of fuel processing, fabricating, or reprocessing, special nuclear material in a quantity exceeding 5,000 grams of contained uranium-235, uranium-233, or plutonium or any combination thereof pursuant to Part 70 of this chapter;

(4) Possess high-level radioactive waste at a geologic repository operations area pursuant to Part 60 of this chapter; or

(5) Possess spent fuel in an independent spent fuel storage installation (ISFSI) pursuant to Part 72 of this chapter; or

(6) Possess or use at any one time, for processing or manufacturing for distribution pursuant to Parts 30, 32, or 33 of this Chapter, byproduct material in quantities exceeding any one of the following quantities:

Radionuclide ¹	Quantity in curies
Cesium-137	1
Cobalt-60	1
Gold-198	100
Iodine-131	1
Iridium-192	10
Krypton-85	1,000
Promethium-147	10
Technetium-99m	1,000

¹The Commission may require as a license condition or by rule, regulation or order pursuant to § 20.602, reports from licensees who are licensed to use radionuclides not on this list in quantities sufficient to cause comparable radiation levels.

§ 20.409 Notifications and reports to individuals.

(a) Requirements for notifications and reports to individuals of exposure to radiation or radioactive material are specified in § 19.13 of this chapter.

(b) When a licensee is required pursuant to §§ 20.405 or 20.408 to report to the Commission any exposure of an individual to radiation or radioactive material, the licensee shall also notify the individual. Such notice shall be transmitted at a time not later than the transmittal to the Commission, and shall comply with the provisions of § 19.13(a) of this chapter.

(7) Receive radioactive waste from other persons for disposal under Part 61 of this chapter.

(b) When an individual terminates employment with a licensee described in paragraph (a) of this section, or an individual assigned to work in such a licensee's facility, but not employed by the licensee, completes the work assignment in the licensee's facility, the licensee shall furnish to the Director, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555, a report of the individual's exposures to radiation and radioactive material, incurred during the period of employment or work assignment in the licensee's facility, containing information recorded by the licensee pursuant to §§ 20.401(a) and 20.106. Such report shall be furnished within 30 days after the exposure of the individual has been determined by the licensee or 90 days after the date of termination of employment or work assignment, whichever is earlier.

EXCEPTIONS AND ADDITIONAL REQUIREMENTS

§ 20.501 Applications for exemptions.

The Commission may, upon application by any licensee or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not result in undue hazard to life or property.

§ 20.502 Additional requirements.

The Commission may, by rule, regulation, or order, impose upon any licensee such requirements, in addition to those established in the regulations in this part, as it deems appropriate or necessary to protect health or to minimize danger to life or property.

ENFORCEMENT

§ 20.601 Violations.

An injunction or other court order may be obtained prohibiting any violation of any provision of the Atomic Energy Act of 1954, as amended, or Title II of the Energy Reorganization Act of 1974, or any regulation or order issued thereunder. A court order may be obtained for the payment of a civil penalty imposed pursuant to section 234 of the Act for violation of section 53, 57, 62, 63, 81, 82, 101, 103, 104, 107, or 109 of the Act, or section 206 of the Energy Reorganization Act of 1974, or any rule, regulation, or order issued thereunder, or any term, condition, or limitation of any license issued thereunder, or for any violation for which a license may be revoked under section 186 of the Act. Any person who willfully violates any provision of the Act or any regulation or order issued thereunder may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

[Note removed 49 FR 19623]

APPENDIX A.—PROTECTION FACTORS FOR RESPIRATORS.^a[illegible]

Note. 3.—Radioactive contaminants for which the concentration values in Table 1, column 1, Appendix B of this part are based on internal dose due to inhalation may, in addition, present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limita-

APPENDIX B

Concentrations in Air and Water Above Natural Background

(See notes at end of appendix)

Element / Atomic number	Isotope	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Actinium	Ac 227	5	2 x 10 ⁻¹²	5 x 10 ⁻¹⁴	2 x 10 ⁻⁴
	Ac 228	5	2 x 10 ⁻¹²	5 x 10 ⁻¹⁴	2 x 10 ⁻⁴
	Ac 229	5	2 x 10 ⁻¹²	5 x 10 ⁻¹⁴	2 x 10 ⁻⁴
Americium (95)	Am 241	5	4 x 10 ⁻¹²	2 x 10 ⁻¹²	4 x 10 ⁻⁴
	Am 242m	5	6 x 10 ⁻¹²	2 x 10 ⁻¹²	4 x 10 ⁻⁴
	Am 242	5	4 x 10 ⁻¹²	2 x 10 ⁻¹²	4 x 10 ⁻⁴
Antimony (51)	Sb 122	5	2 x 10 ⁻⁷	2 x 10 ⁻⁷	2 x 10 ⁻³
	Sb 124	5	2 x 10 ⁻⁷	2 x 10 ⁻⁷	2 x 10 ⁻³
	Sb 125	5	2 x 10 ⁻⁷	2 x 10 ⁻⁷	2 x 10 ⁻³
Argon (18)	Ar 37	Sub ¹	6 x 10 ⁻¹²	1 x 10 ⁻¹²	1 x 10 ⁻⁴
	Ar 41	Sub	2 x 10 ⁻¹²	4 x 10 ⁻¹²	4 x 10 ⁻⁴
	Ar 42	5	2 x 10 ⁻¹²	2 x 10 ⁻¹²	2 x 10 ⁻⁴
Arsenic (33)	As 73	5	4 x 10 ⁻⁷	1 x 10 ⁻⁷	5 x 10 ⁻³
	As 74	5	2 x 10 ⁻⁷	2 x 10 ⁻⁷	2 x 10 ⁻³
	As 76	5	1 x 10 ⁻⁷	6 x 10 ⁻⁸	2 x 10 ⁻³
Astatine (85)	At 211	5	7 x 10 ⁻¹²	2 x 10 ⁻¹²	2 x 10 ⁻⁴
	At 212	5	2 x 10 ⁻¹²	2 x 10 ⁻¹²	2 x 10 ⁻⁴
	At 213	5	2 x 10 ⁻¹²	2 x 10 ⁻¹²	2 x 10 ⁻⁴
Barium (56)	Ba 131	5	1 x 10 ⁻⁷	5 x 10 ⁻⁸	2 x 10 ⁻³
	Ba 140	5	1 x 10 ⁻⁷	5 x 10 ⁻⁸	2 x 10 ⁻³
	Ba 141	5	1 x 10 ⁻⁷	5 x 10 ⁻⁸	2 x 10 ⁻³
Berkelium (97)	Bk 249	5	9 x 10 ⁻¹²	2 x 10 ⁻¹²	4 x 10 ⁻⁴
	Bk 250	5	1 x 10 ⁻¹²	2 x 10 ⁻¹²	4 x 10 ⁻⁴
	Bk 251	5	1 x 10 ⁻¹²	2 x 10 ⁻¹²	4 x 10 ⁻⁴
Beryllium (4)	Be 7	5	4 x 10 ⁻¹²	2 x 10 ⁻¹²	2 x 10 ⁻⁴
	Be 10	5	1 x 10 ⁻¹²	2 x 10 ⁻¹²	2 x 10 ⁻⁴
	Be 11	5	1 x 10 ⁻¹²	2 x 10 ⁻¹²	2 x 10 ⁻⁴
Bismuth (83)	Bi 206	5	2 x 10 ⁻⁷	1 x 10 ⁻⁷	4 x 10 ⁻³
	Bi 207	5	2 x 10 ⁻⁷	1 x 10 ⁻⁷	4 x 10 ⁻³
	Bi 210	5	2 x 10 ⁻⁷	1 x 10 ⁻⁷	4 x 10 ⁻³
Bismuth (83)	Bi 210	5	2 x 10 ⁻⁷	1 x 10 ⁻⁷	4 x 10 ⁻³
	Bi 211	5	2 x 10 ⁻⁷	1 x 10 ⁻⁷	4 x 10 ⁻³
	Bi 212	5	2 x 10 ⁻⁷	1 x 10 ⁻⁷	4 x 10 ⁻³

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

[See notes at end of appendix]

Element (atomic number)	Isotope ¹		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Bromine (35)	Br 82	S	1 × 10 ⁻⁴	8 × 10 ⁻³	4 × 10 ⁻⁴	3 × 10 ⁻⁴
Cadmium (48)	Cd 109	I	2 × 10 ⁻⁷	1 × 10 ⁻³	4 × 10 ⁻³	4 × 10 ⁻³
		S	3 × 10 ⁻⁴	5 × 10 ⁻³	2 × 10 ⁻³	2 × 10 ⁻⁴
	Cd 115m	I	7 × 10 ⁻⁴	3 × 10 ⁻³	3 × 10 ⁻³	2 × 10 ⁻⁴
		S	2 × 10 ⁻³	7 × 10 ⁻⁴	1 × 10 ⁻³	3 × 10 ⁻³
Calcium (20)	Ca 45	I	4 × 10 ⁻⁵	7 × 10 ⁻⁴	1 × 10 ⁻³	3 × 10 ⁻³
		S	2 × 10 ⁻⁷	1 × 10 ⁻³	8 × 10 ⁻⁴	3 × 10 ⁻³
	Ca 47	I	3 × 10 ⁻⁷	1 × 10 ⁻³	4 × 10 ⁻³	3 × 10 ⁻⁴
		S	1 × 10 ⁻⁷	3 × 10 ⁻³	4 × 10 ⁻³	3 × 10 ⁻⁴
Californium (98)	Cf 249	S	2 × 10 ⁻¹²	1 × 10 ⁻⁴	5 × 10 ⁻¹⁴	4 × 10 ⁻⁴
		I	1 × 10 ⁻¹⁴	7 × 10 ⁻⁴	3 × 10 ⁻¹²	2 × 10 ⁻³
	Cf 250	S	5 × 10 ⁻¹²	4 × 10 ⁻⁴	2 × 10 ⁻¹²	1 × 10 ⁻³
		I	1 × 10 ⁻¹⁴	7 × 10 ⁻⁴	3 × 10 ⁻¹²	2 × 10 ⁻³
	Cf 251	S	2 × 10 ⁻¹²	1 × 10 ⁻⁴	6 × 10 ⁻¹⁴	4 × 10 ⁻⁴
		I	1 × 10 ⁻¹⁴	8 × 10 ⁻⁴	3 × 10 ⁻¹²	3 × 10 ⁻³
	Cf 252	S	6 × 10 ⁻¹²	2 × 10 ⁻⁴	2 × 10 ⁻¹²	7 × 10 ⁻⁴
		I	3 × 10 ⁻¹¹	2 × 10 ⁻⁴	1 × 10 ⁻¹²	7 × 10 ⁻⁴
	Cf 253	S	8 × 10 ⁻¹²	4 × 10 ⁻⁴	2 × 10 ⁻¹¹	1 × 10 ⁻⁴
		I	8 × 10 ⁻¹⁴	4 × 10 ⁻⁴	3 × 10 ⁻¹¹	1 × 10 ⁻⁴
Carbon (6)	C 14	S	5 × 10 ⁻¹²	4 × 10 ⁻⁴	2 × 10 ⁻¹²	1 × 10 ⁻³
		I	5 × 10 ⁻¹²	4 × 10 ⁻⁴	2 × 10 ⁻¹²	1 × 10 ⁻³
	(CO ₂)	S	4 × 10 ⁻⁴	2 × 10 ⁻³	1 × 10 ⁻⁷	8 × 10 ⁻⁴
		Sub	5 × 10 ⁻³		1 × 10 ⁻⁴	
Cesium (55)	Cs 141	S	4 × 10 ⁻⁷	3 × 10 ⁻³	2 × 10 ⁻⁴	9 × 10 ⁻³
		I	2 × 10 ⁻⁷	3 × 10 ⁻³	3 × 10 ⁻⁴	9 × 10 ⁻³
	Cs 142	S	3 × 10 ⁻⁷	1 × 10 ⁻³	9 × 10 ⁻⁴	4 × 10 ⁻³
		I	2 × 10 ⁻⁷	1 × 10 ⁻³	7 × 10 ⁻⁴	4 × 10 ⁻³
Cesium (55)	Cs 144	S	1 × 10 ⁻⁴	3 × 10 ⁻⁴	3 × 10 ⁻⁴	1 × 10 ⁻³
		I	6 × 10 ⁻⁴	3 × 10 ⁻⁴	2 × 10 ⁻⁴	1 × 10 ⁻³
	Cs 131	S	1 × 10 ⁻³	7 × 10 ⁻³	4 × 10 ⁻⁷	2 × 10 ⁻³
		I	3 × 10 ⁻⁴	3 × 10 ⁻³	1 × 10 ⁻⁷	9 × 10 ⁻⁴
	Cs 134m	S	4 × 10 ⁻³	2 × 10 ⁻³	1 × 10 ⁻⁴	6 × 10 ⁻³
		I	6 × 10 ⁻⁴	3 × 10 ⁻³	2 × 10 ⁻⁷	1 × 10 ⁻³
	Cs 134	S	4 × 10 ⁻⁴	3 × 10 ⁻⁴	1 × 10 ⁻⁴	9 × 10 ⁻⁴
		I	1 × 10 ⁻⁴	1 × 10 ⁻³	4 × 10 ⁻⁴	4 × 10 ⁻³
	Cs 135	S	5 × 10 ⁻⁷	3 × 10 ⁻³	2 × 10 ⁻⁴	1 × 10 ⁻⁴
		I	9 × 10 ⁻⁴	7 × 10 ⁻³	3 × 10 ⁻⁴	2 × 10 ⁻⁴
	Cs 136	S	4 × 10 ⁻⁷	2 × 10 ⁻³	1 × 10 ⁻⁴	9 × 10 ⁻³
		I	2 × 10 ⁻⁷	2 × 10 ⁻³	6 × 10 ⁻⁴	6 × 10 ⁻³
Chlorine (17)	Cl 36	S	6 × 10 ⁻⁴	4 × 10 ⁻⁴	3 × 10 ⁻⁴	3 × 10 ⁻³
		I	1 × 10 ⁻⁴	1 × 10 ⁻³	8 × 10 ⁻⁴	4 × 10 ⁻³
	Cl 38	S	4 × 10 ⁻⁷	2 × 10 ⁻³	1 × 10 ⁻⁴	8 × 10 ⁻³
		I	2 × 10 ⁻⁴	2 × 10 ⁻³	8 × 10 ⁻⁴	6 × 10 ⁻³
Chromium (24)	Cr 51	S	3 × 10 ⁻⁴	5 × 10 ⁻⁴	9 × 10 ⁻⁴	4 × 10 ⁻⁴
		I	1 × 10 ⁻³	5 × 10 ⁻⁴	7 × 10 ⁻⁴	4 × 10 ⁻⁴

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix.)

Element (atomic number)	Isotope	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Cobalt (27)	Co 57	5	2×10^{-4}	1×10^{-7}	5×10^{-4}
	Co 58	1	2×10^{-7}	6×10^{-7}	4×10^{-4}
	Co 58m	5	2×10^{-7}	6×10^{-7}	3×10^{-7}
	Co 59	1	9×10^{-7}	2×10^{-7}	2×10^{-7}
	Co 60	5	2×10^{-7}	4×10^{-7}	1×10^{-4}
Copper (29)	Co 64	1	2×10^{-7}	2×10^{-7}	9×10^{-7}
	Co 64	5	2×10^{-7}	1×10^{-7}	5×10^{-7}
	Co 64	1	9×10^{-7}	1×10^{-7}	2×10^{-7}
Curium (96)	Cur 242	5	2×10^{-4}	7×10^{-11}	2×10^{-4}
	Cur 242	5	1×10^{-4}	4×10^{-11}	2×10^{-7}
	Cur 242	1	6×10^{-11}	1×10^{-11}	5×10^{-11}
	Cur 244	5	1×10^{-11}	7×10^{-11}	2×10^{-11}
	Cur 244	1	9×10^{-11}	2×10^{-11}	2×10^{-11}
	Cur 244	1	1×10^{-11}	2×10^{-11}	7×10^{-11}
	Cur 245	5	2×10^{-11}	2×10^{-11}	2×10^{-11}
	Cur 245	1	1×10^{-11}	4×10^{-11}	3×10^{-11}
	Cur 246	5	2×10^{-11}	2×10^{-11}	4×10^{-11}
	Cur 246	1	1×10^{-11}	2×10^{-11}	2×10^{-11}
	Cur 247	5	2×10^{-11}	2×10^{-11}	4×10^{-11}
	Cur 247	1	1×10^{-11}	4×10^{-11}	2×10^{-11}
	Cur 248	5	6×10^{-11}	2×10^{-11}	4×10^{-11}
	Cur 248	1	1×10^{-11}	4×10^{-11}	1×10^{-11}
	Cur 249	5	1×10^{-11}	6×10^{-11}	2×10^{-11}
Dysprosium (66)	Dy 163	5	2×10^{-4}	1×10^{-7}	4×10^{-4}
	Dy 163	1	2×10^{-4}	7×10^{-7}	4×10^{-4}
	Dy 166	5	2×10^{-7}	1×10^{-7}	6×10^{-7}
Einsteinium (99)	Eis 253	5	2×10^{-7}	1×10^{-7}	4×10^{-7}
	Eis 253	1	8×10^{-11}	7×10^{-11}	2×10^{-11}
	Eis 254m	5	6×10^{-11}	7×10^{-11}	2×10^{-11}
	Eis 254m	1	2×10^{-11}	2×10^{-11}	2×10^{-11}
	Eis 254	5	6×10^{-11}	2×10^{-11}	2×10^{-11}
	Eis 254	1	2×10^{-11}	4×10^{-11}	1×10^{-11}
	Eis 255	5	1×10^{-11}	4×10^{-11}	1×10^{-11}
Berkelium (68)	Ber 169	5	2×10^{-4}	2×10^{-11}	2×10^{-11}
	Ber 169	1	4×10^{-7}	1×10^{-11}	2×10^{-11}
	Ber 171	5	6×10^{-7}	2×10^{-11}	9×10^{-11}
Berkelium (68)	Ber 171	1	7×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	5	6×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	1	4×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	5	4×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	1	4×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	5	4×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	1	4×10^{-7}	2×10^{-11}	1×10^{-11}
Berkelium (68)	Ber 171	5	4×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	1	4×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	5	4×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	1	4×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	5	4×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	1	4×10^{-7}	2×10^{-11}	1×10^{-11}
	Ber 171	5	4×10^{-7}	2×10^{-11}	1×10^{-11}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air + (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Fermium (100)	Fm 254	5	6×10^{-14}	4×10^{-13}	2×10^{-14}	1×10^{-14}
		1	7×10^{-14}	4×10^{-13}	2×10^{-14}	1×10^{-14}
	Fm 255	5	2×10^{-14}	1×10^{-13}	6×10^{-14}	3×10^{-13}
		1	1×10^{-14}	1×10^{-13}	4×10^{-14}	3×10^{-13}
	Fm 256	5	3×10^{-14}	3×10^{-13}	1×10^{-14}	9×10^{-13}
Fluorine (9)	F 12	5	3×10^{-14}	3×10^{-13}	6×10^{-14}	9×10^{-13}
		1	5×10^{-14}	2×10^{-13}	2×10^{-14}	8×10^{-13}
Gadolinium (64)	Gd 152	5	3×10^{-14}	1×10^{-13}	9×10^{-14}	5×10^{-13}
		1	2×10^{-14}	6×10^{-13}	8×10^{-14}	2×10^{-12}
	Gd 159	5	9×10^{-14}	6×10^{-13}	3×10^{-14}	2×10^{-12}
Gallium (31)	Ga 72	5	2×10^{-14}	3×10^{-13}	2×10^{-14}	8×10^{-13}
		1	2×10^{-14}	1×10^{-13}	8×10^{-14}	4×10^{-13}
		1	2×10^{-14}	1×10^{-13}	6×10^{-14}	4×10^{-13}
Germanium (32)	Ge 71	5	1×10^{-14}	5×10^{-13}	4×10^{-14}	2×10^{-12}
		1	6×10^{-14}	5×10^{-13}	2×10^{-14}	2×10^{-12}
Gold (79)	Au 196	5	1×10^{-14}	5×10^{-13}	4×10^{-14}	2×10^{-12}
		1	6×10^{-14}	4×10^{-13}	3×10^{-14}	1×10^{-12}
	Au 198	5	3×10^{-14}	2×10^{-13}	1×10^{-14}	5×10^{-13}
		1	2×10^{-14}	1×10^{-13}	8×10^{-14}	5×10^{-13}
Hafnium (72)	Hf 181	5	1×10^{-14}	5×10^{-13}	4×10^{-14}	2×10^{-12}
		1	8×10^{-14}	4×10^{-13}	3×10^{-14}	2×10^{-12}
		1	4×10^{-14}	2×10^{-13}	1×10^{-14}	7×10^{-13}
Helmium (67)	He 186	5	7×10^{-14}	2×10^{-13}	2×10^{-14}	7×10^{-13}
		1	2×10^{-14}	9×10^{-14}	7×10^{-14}	3×10^{-13}
Hydrogen (1)	H3	5	3×10^{-14}	1×10^{-13}	6×10^{-14}	3×10^{-13}
		1	5×10^{-14}	1×10^{-13}	2×10^{-14}	3×10^{-13}
		Sub	3×10^{-14}		4×10^{-14}	
Indium (49)	In 112m	5	8×10^{-14}	4×10^{-13}	3×10^{-14}	1×10^{-12}
		1	7×10^{-14}	4×10^{-13}	2×10^{-14}	1×10^{-12}
	In 114m	5	1×10^{-14}	5×10^{-13}	4×10^{-14}	2×10^{-12}
		1	2×10^{-14}	5×10^{-13}	7×10^{-14}	3×10^{-12}
	In 113m	5	2×10^{-14}	1×10^{-13}	8×10^{-14}	4×10^{-12}
		1	3×10^{-14}	1×10^{-13}	6×10^{-14}	4×10^{-12}
	In 115	5	2×10^{-14}	3×10^{-13}	9×10^{-14}	9×10^{-13}
Iodine (53)	I 125	5	3×10^{-14}	3×10^{-13}	1×10^{-14}	9×10^{-13}
		1	5×10^{-14}	4×10^{-13}	8×10^{-14}	2×10^{-12}
		1	2×10^{-14}	6×10^{-13}	6×10^{-14}	3×10^{-12}
	I 126	5	8×10^{-14}	5×10^{-13}	9×10^{-14}	3×10^{-12}
		1	3×10^{-14}	3×10^{-13}	1×10^{-14}	9×10^{-13}
	I 129	5	2×10^{-14}	1×10^{-13}	2×10^{-14}	6×10^{-13}
		1	7×10^{-14}	6×10^{-13}	3×10^{-14}	2×10^{-12}
	I 131	5	9×10^{-14}	6×10^{-13}	1×10^{-14}	3×10^{-12}
		1	2×10^{-14}	3×10^{-13}	1×10^{-14}	6×10^{-13}
	I 132	5	2×10^{-14}	2×10^{-13}	3×10^{-14}	3×10^{-12}
		1	9×10^{-14}	5×10^{-13}	3×10^{-14}	2×10^{-12}
	I 133	5	3×10^{-14}	2×10^{-13}	4×10^{-14}	1×10^{-12}
		1	2×10^{-14}	1×10^{-13}	7×10^{-14}	4×10^{-13}
	I 134	5	5×10^{-14}	4×10^{-13}	6×10^{-14}	2×10^{-12}

PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope ¹		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Iodine (53)	I 134	I	2×10^{-4}	2×10^{-3}	1×10^{-7}	6×10^{-4}
	I 135	S	1×10^{-7}	7×10^{-4}	1×10^{-9}	4×10^{-4}
	I	I	4×10^{-7}	2×10^{-3}	1×10^{-4}	7×10^{-3}
Bridium (77)	Br 190	S	1×10^{-4}	6×10^{-3}	4×10^{-4}	2×10^{-4}
	Br	I	4×10^{-7}	5×10^{-3}	1×10^{-4}	2×10^{-4}
	Br 192	S	1×10^{-7}	1×10^{-3}	4×10^{-4}	4×10^{-4}
	Br	I	2×10^{-4}	1×10^{-3}	9×10^{-10}	4×10^{-4}
	Br 194	S	2×10^{-7}	1×10^{-3}	8×10^{-4}	3×10^{-4}
	Br	I	2×10^{-7}	9×10^{-4}	8×10^{-4}	3×10^{-4}
Bron (36)	Fe 55	S	9×10^{-7}	2×10^{-3}	2×10^{-4}	8×10^{-4}
	Fe	I	1×10^{-4}	7×10^{-3}	2×10^{-4}	2×10^{-4}
	Fe 59	S	1×10^{-7}	2×10^{-3}	5×10^{-4}	6×10^{-4}
	Fe	I	5×10^{-4}	2×10^{-3}	2×10^{-4}	5×10^{-4}
Krypton (36)	Kr 83m	Sub	6×10^{-4}		1×10^{-7}	
	Kr 83	Sub	1×10^{-3}		2×10^{-7}	
	Kr 87	Sub	1×10^{-4}		2×10^{-4}	
	Kr 88	Sub	1×10^{-4}		2×10^{-4}	
Lanthanum (57)	La 140	S	2×10^{-7}	7×10^{-4}	5×10^{-4}	2×10^{-4}
	La	I	1×10^{-7}	7×10^{-4}	4×10^{-4}	2×10^{-4}
Lead (82)	Pb 203	S	2×10^{-4}	1×10^{-3}	9×10^{-4}	4×10^{-4}
	Pb	I	2×10^{-4}	1×10^{-3}	6×10^{-4}	4×10^{-4}
	Pb 210	S	1×10^{-10}	4×10^{-4}	4×10^{-12}	1×10^{-4}
	Pb	I	2×10^{-10}	8×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb 212	S	2×10^{-4}	4×10^{-4}	6×10^{-10}	2×10^{-4}
	Pb	I	2×10^{-4}	5×10^{-4}	7×10^{-10}	2×10^{-4}
Lutetium (71)	Lu 177	S	4×10^{-7}	2×10^{-3}	2×10^{-4}	1×10^{-4}
	Lu	I	5×10^{-7}	2×10^{-3}	2×10^{-4}	1×10^{-4}
Manganese (25)	Mn 52	S	2×10^{-7}	1×10^{-3}	7×10^{-4}	3×10^{-4}
	Mn	I	1×10^{-7}	9×10^{-4}	5×10^{-4}	3×10^{-4}
	Mn 54	S	4×10^{-7}	4×10^{-3}	1×10^{-4}	1×10^{-4}
	Mn	I	4×10^{-7}	3×10^{-3}	1×10^{-4}	1×10^{-4}
	Mn 56	S	8×10^{-7}	4×10^{-3}	2×10^{-4}	1×10^{-4}
	Mn	I	5×10^{-7}	3×10^{-3}	2×10^{-4}	1×10^{-4}
Mercury (80)	Hg 197m	S	7×10^{-7}	4×10^{-3}	2×10^{-4}	2×10^{-4}
	Hg	I	8×10^{-7}	5×10^{-3}	2×10^{-4}	2×10^{-4}
	Hg 197	S	1×10^{-4}	9×10^{-3}	4×10^{-4}	2×10^{-4}
	Hg	I	3×10^{-4}	1×10^{-3}	9×10^{-4}	5×10^{-4}
	Hg 203	S	7×10^{-4}	5×10^{-3}	2×10^{-4}	2×10^{-4}
	Hg	I	1×10^{-7}	2×10^{-3}	4×10^{-4}	1×10^{-4}
Molybdenum (42)	Mo 99	S	7×10^{-7}	5×10^{-3}	2×10^{-4}	2×10^{-4}
	Mo	I	2×10^{-7}	1×10^{-3}	7×10^{-4}	4×10^{-4}
Neodymium (60)	Nd 144	S	8×10^{-11}	2×10^{-3}	2×10^{-10}	7×10^{-4}
	Nd	I	5×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-4}
	Nd 147	S	4×10^{-7}	2×10^{-3}	1×10^{-4}	6×10^{-4}
	Nd	I	2×10^{-7}	2×10^{-3}	8×10^{-4}	6×10^{-4}
	Nd 149	S	2×10^{-4}	8×10^{-3}	5×10^{-4}	2×10^{-4}
	Nd	I	1×10^{-4}	8×10^{-3}	5×10^{-4}	2×10^{-4}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope ¹		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Neptunium (93)	Np 237	S	4×10^{-11}	9×10^{-4}	1×10^{-13}	3×10^{-4}
	Np 239	S	1×10^{-10}	9×10^{-4}	4×10^{-13}	3×10^{-4}
Nickel (28)	Ni 59	I	8×10^{-7}	4×10^{-3}	3×10^{-2}	1×10^{-4}
	Ni 63	I	7×10^{-7}	4×10^{-3}	2×10^{-2}	1×10^{-4}
	Ni 63	I	5×10^{-7}	6×10^{-3}	3×10^{-2}	2×10^{-4}
	Ni 63	I	8×10^{-7}	6×10^{-3}	1×10^{-2}	3×10^{-4}
	Ni 63	I	4×10^{-7}	8×10^{-3}	2×10^{-2}	3×10^{-4}
Niobium (Columbium) (41)	Nb 93m	S	3×10^{-7}	2×10^{-3}	1×10^{-2}	7×10^{-4}
	Nb 93	S	9×10^{-7}	4×10^{-3}	3×10^{-2}	1×10^{-4}
	Nb 93	I	3×10^{-7}	3×10^{-3}	2×10^{-2}	1×10^{-4}
	Nb 93	I	1×10^{-7}	3×10^{-3}	3×10^{-2}	1×10^{-4}
	Nb 97	S	6×10^{-7}	3×10^{-3}	2×10^{-2}	9×10^{-4}
Osmium (76)	Os 185	S	5×10^{-7}	3×10^{-3}	2×10^{-2}	9×10^{-4}
	Os 185	I	5×10^{-7}	3×10^{-3}	2×10^{-2}	7×10^{-4}
	Os 191m	S	3×10^{-7}	7×10^{-3}	4×10^{-2}	2×10^{-3}
	Os 191	I	9×10^{-7}	7×10^{-3}	3×10^{-2}	2×10^{-3}
	Os 193	S	1×10^{-6}	5×10^{-3}	4×10^{-2}	2×10^{-3}
Palladium (46)	Pd 103	S	4×10^{-7}	5×10^{-3}	1×10^{-2}	2×10^{-3}
	Pd 103	I	3×10^{-7}	3×10^{-3}	1×10^{-2}	6×10^{-4}
	Pd 109	S	7×10^{-7}	2×10^{-3}	9×10^{-2}	5×10^{-3}
Phosphorus (15)	P 32	S	1×10^{-6}	1×10^{-3}	5×10^{-4}	3×10^{-4}
	P 32	I	7×10^{-6}	8×10^{-3}	3×10^{-4}	3×10^{-4}
Platinum (78)	Pt 191	S	6×10^{-7}	3×10^{-3}	2×10^{-2}	1×10^{-4}
	Pt 191	I	8×10^{-7}	4×10^{-3}	2×10^{-2}	1×10^{-4}
	Pt 193m	S	7×10^{-7}	3×10^{-3}	2×10^{-2}	1×10^{-4}
	Pt 193m	I	5×10^{-7}	3×10^{-3}	2×10^{-2}	1×10^{-4}
	Pt 193	S	1×10^{-6}	3×10^{-3}	4×10^{-2}	9×10^{-4}
Plutonium (94)	Pu 238	S	3×10^{-11}	1×10^{-4}	7×10^{-14}	3×10^{-4}
	Pu 238	I	3×10^{-11}	8×10^{-4}	1×10^{-13}	3×10^{-4}
	Pu 239	S	2×10^{-11}	1×10^{-4}	6×10^{-14}	3×10^{-4}
	Pu 239	I	4×10^{-11}	8×10^{-4}	1×10^{-13}	3×10^{-4}
	Pu 240	S	2×10^{-11}	1×10^{-4}	6×10^{-14}	3×10^{-4}
	Pu 241	S	4×10^{-11}	8×10^{-4}	1×10^{-13}	3×10^{-4}
	Pu 241	I	9×10^{-11}	7×10^{-4}	2×10^{-13}	2×10^{-4}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope	†	Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)
Plutonium (94)	Pu 242	S	2×10^{-12}	1×10^{-14}	6×10^{-14}	5×10^{-14}
	Pu 243	I	4×10^{-11}	9×10^{-14}	1×10^{-12}	2×10^{-12}
	Pu 244	S	2×10^{-12}	1×10^{-14}	6×10^{-14}	5×10^{-14}
	Pu 245	I	2×10^{-12}	1×10^{-14}	6×10^{-14}	5×10^{-14}
Polonium (84)	Po 210	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Po 211	I	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Po 212	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Po 213	I	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
Protactinium (91)	Pa 231	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Pa 232	I	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Pa 233	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Pa 234	I	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
Radium (88)	Ra 226	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Ra 228	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Ra 229	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Ra 230	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
Rhenium (75)	Re 185	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Re 186	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Re 187	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Re 188	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
Rhodium (45)	Rh 103m	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Rh 105	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Rh 106	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Rh 107	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
Ruthenium (44)	Ru 96	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Ru 98	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Ru 100	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}
	Ru 101	S	2×10^{-12}	2×10^{-12}	2×10^{-12}	7×10^{-12}

APPENDIX B
Concentrations in Air and Water Above Natural Background—Continued
(See notes at end of appendix)

Element (atomic number)	Isotope		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air + ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)
Ruthenium (44)	Ru 97	S	2×10^{-4}	1×10^{-3}	8×10^{-4}	4×10^{-4}
		I	2×10^{-4}	1×10^{-3}	6×10^{-4}	3×10^{-4}
	Ru 103	S	5×10^{-3}	3×10^{-3}	2×10^{-3}	8×10^{-4}
		I	8×10^{-3}	3×10^{-3}	3×10^{-3}	5×10^{-4}
	Ru 105	S	7×10^{-3}	3×10^{-3}	2×10^{-3}	1×10^{-3}
		I	5×10^{-3}	3×10^{-3}	2×10^{-3}	1×10^{-3}
Rhodium (45)	Rh 106	S	8×10^{-3}	4×10^{-3}	3×10^{-3}	1×10^{-3}
		I	6×10^{-3}	3×10^{-3}	2×10^{-3}	1×10^{-3}
	Sm 147	S	7×10^{-11}	2×10^{-12}	2×10^{-12}	6×10^{-12}
		I	3×10^{-10}	2×10^{-11}	9×10^{-12}	7×10^{-11}
	Sm 151	S	6×10^{-10}	1×10^{-11}	2×10^{-11}	4×10^{-11}
		I	1×10^{-9}	1×10^{-10}	3×10^{-11}	4×10^{-11}
Samarium (62)	Sm 153	S	5×10^{-7}	2×10^{-7}	2×10^{-8}	8×10^{-8}
		I	4×10^{-7}	2×10^{-7}	1×10^{-8}	8×10^{-8}
Scandium (21)	Sc 46	S	2×10^{-7}	1×10^{-7}	8×10^{-8}	4×10^{-7}
		I	3×10^{-8}	1×10^{-7}	8×10^{-8}	4×10^{-7}
	Sc 47	S	6×10^{-7}	3×10^{-7}	2×10^{-8}	9×10^{-7}
		I	5×10^{-7}	2×10^{-7}	2×10^{-8}	9×10^{-7}
	Sc 48	S	2×10^{-7}	8×10^{-8}	6×10^{-8}	3×10^{-7}
		I	1×10^{-7}	8×10^{-8}	5×10^{-8}	3×10^{-7}
Selenium (34)	Se 75	S	1×10^{-7}	9×10^{-8}	4×10^{-8}	3×10^{-7}
		I	1×10^{-7}	8×10^{-8}	4×10^{-8}	3×10^{-7}
Silicon (14)	Si 31	S	6×10^{-8}	3×10^{-7}	2×10^{-7}	9×10^{-8}
		I	1×10^{-8}	6×10^{-8}	3×10^{-8}	2×10^{-8}
Silver (47)	Ag 103	S	6×10^{-7}	2×10^{-7}	2×10^{-8}	1×10^{-7}
		I	8×10^{-8}	3×10^{-7}	3×10^{-8}	1×10^{-7}
	Ag 110m	S	2×10^{-7}	9×10^{-8}	7×10^{-8}	3×10^{-7}
		I	1×10^{-8}	9×10^{-8}	3×10^{-8}	3×10^{-7}
	Ag 111	S	2×10^{-7}	1×10^{-7}	1×10^{-8}	4×10^{-7}
		I	2×10^{-7}	1×10^{-7}	8×10^{-8}	4×10^{-7}
Sodium (11)	Na 22	S	2×10^{-7}	1×10^{-7}	6×10^{-8}	4×10^{-7}
		I	9×10^{-8}	9×10^{-8}	3×10^{-8}	3×10^{-7}
	Na 24	S	1×10^{-4}	1×10^{-7}	4×10^{-8}	2×10^{-7}
		I	1×10^{-7}	8×10^{-8}	5×10^{-8}	3×10^{-7}
Strontium (38)	Sr 85m	S	4×10^{-7}	2×10^{-7}	1×10^{-8}	7×10^{-7}
		I	3×10^{-7}	2×10^{-7}	1×10^{-8}	7×10^{-7}
	Sr 87	S	2×10^{-7}	3×10^{-7}	8×10^{-8}	1×10^{-7}
		I	1×10^{-7}	5×10^{-7}	4×10^{-8}	2×10^{-7}
	Sr 89	S	3×10^{-7}	2×10^{-7}	3×10^{-8}	3×10^{-7}
		I	4×10^{-8}	8×10^{-8}	1×10^{-8}	3×10^{-7}
	Sr 90	S	1×10^{-8}	1×10^{-7}	3×10^{-11}	3×10^{-7}
		I	5×10^{-9}	1×10^{-7}	2×10^{-10}	4×10^{-7}
	Sr 91	S	4×10^{-7}	2×10^{-7}	2×10^{-8}	7×10^{-7}
		I	3×10^{-7}	1×10^{-7}	9×10^{-8}	5×10^{-7}
	Sr 92	S	4×10^{-7}	2×10^{-7}	2×10^{-8}	7×10^{-7}
		I	2×10^{-7}	2×10^{-7}	1×10^{-8}	6×10^{-7}
Sulfur (16)	S 33	S	3×10^{-7}	2×10^{-7}	9×10^{-8}	6×10^{-7}
		I	3×10^{-7}	2×10^{-7}	9×10^{-8}	3×10^{-7}
Tantalum (73)	Ta 182	S	4×10^{-8}	1×10^{-7}	1×10^{-8}	4×10^{-7}
		I	2×10^{-8}	1×10^{-7}	7×10^{-8}	4×10^{-7}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued
 (See notes at end of appendix)

Element (atomic number)	Isotope		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air \dagger ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)
Technetium (43)	Tc 96m	S	8×10^{-7}	4×10^{-7}	2×10^{-6}	1×10^{-6}
		I	3×10^{-7}	3×10^{-7}	1×10^{-6}	1×10^{-6}
	Tc 96	S	6×10^{-7}	7×10^{-7}	3×10^{-6}	1×10^{-6}
		I	2×10^{-7}	1×10^{-7}	8×10^{-7}	3×10^{-7}
	Tc 97m	S	3×10^{-7}	1×10^{-7}	3×10^{-6}	4×10^{-6}
		I	2×10^{-7}	3×10^{-7}	3×10^{-6}	3×10^{-6}
	Tc 97	S	1×10^{-7}	3×10^{-7}	4×10^{-7}	2×10^{-7}
		I	3×10^{-7}	2×10^{-7}	1×10^{-6}	8×10^{-7}
	Tc 99m	S	4×10^{-7}	2×10^{-7}	1×10^{-6}	6×10^{-7}
		I	1×10^{-7}	8×10^{-7}	5×10^{-7}	3×10^{-7}
Tellurium (52)	Tc 99	S	2×10^{-6}	1×10^{-6}	7×10^{-6}	3×10^{-6}
		I	6×10^{-6}	5×10^{-6}	2×10^{-5}	3×10^{-5}
	Te 125m	S	4×10^{-7}	5×10^{-7}	1×10^{-6}	2×10^{-6}
		I	1×10^{-7}	3×10^{-7}	4×10^{-6}	1×10^{-6}
	Te 127m	S	1×10^{-7}	2×10^{-7}	3×10^{-6}	6×10^{-7}
		I	4×10^{-8}	3×10^{-8}	1×10^{-6}	5×10^{-7}
	Te 127	S	2×10^{-8}	8×10^{-8}	5×10^{-6}	3×10^{-6}
		I	9×10^{-8}	5×10^{-8}	2×10^{-6}	2×10^{-6}
	Te 129m	S	8×10^{-8}	1×10^{-7}	3×10^{-6}	3×10^{-6}
		I	3×10^{-8}	6×10^{-8}	1×10^{-6}	2×10^{-6}
Terbium (63)	Te 129	S	5×10^{-8}	2×10^{-7}	2×10^{-6}	8×10^{-6}
		I	4×10^{-8}	2×10^{-7}	1×10^{-6}	8×10^{-6}
	Te 131m	S	4×10^{-7}	2×10^{-7}	1×10^{-6}	4×10^{-6}
		I	2×10^{-7}	1×10^{-7}	6×10^{-6}	4×10^{-6}
	Te 132	S	2×10^{-7}	9×10^{-8}	7×10^{-6}	3×10^{-6}
		I	1×10^{-7}	6×10^{-8}	4×10^{-6}	2×10^{-6}
	Tb 140	S	1×10^{-7}	1×10^{-7}	3×10^{-6}	4×10^{-6}
		I	2×10^{-8}	1×10^{-8}	1×10^{-6}	4×10^{-6}
	Ti 200	S	3×10^{-8}	1×10^{-8}	9×10^{-6}	4×10^{-6}
		I	1×10^{-8}	7×10^{-8}	4×10^{-6}	2×10^{-6}
Thallium (81)	Ti 201	S	2×10^{-8}	9×10^{-8}	7×10^{-6}	2×10^{-6}
		I	9×10^{-8}	5×10^{-8}	3×10^{-6}	2×10^{-6}
	Ti 202	S	8×10^{-8}	4×10^{-8}	2×10^{-6}	1×10^{-6}
		I	2×10^{-8}	3×10^{-8}	5×10^{-6}	7×10^{-6}
	Ti 204	S	4×10^{-8}	3×10^{-8}	2×10^{-6}	1×10^{-6}
		I	2×10^{-8}	2×10^{-8}	9×10^{-6}	6×10^{-6}
	Th 227	S	3×10^{-10}	5×10^{-10}	1×10^{-11}	2×10^{-11}
		I	2×10^{-10}	5×10^{-10}	6×10^{-11}	2×10^{-11}
	Th 228	S	9×10^{-11}	3×10^{-10}	3×10^{-11}	7×10^{-11}
		I	6×10^{-11}	4×10^{-10}	2×10^{-11}	1×10^{-11}
Thorium (90)	Th 230	S	2×10^{-11}	5×10^{-11}	8×10^{-12}	2×10^{-11}
		I	1×10^{-11}	9×10^{-11}	3×10^{-11}	3×10^{-11}
	Th 231	S	1×10^{-10}	7×10^{-11}	5×10^{-11}	2×10^{-11}
		I	1×10^{-10}	7×10^{-11}	4×10^{-11}	2×10^{-11}
	Th 232	S	3×10^{-11}	5×10^{-11}	1×10^{-11}	2×10^{-11}
		I	3×10^{-11}	1×10^{-11}	1×10^{-11}	5×10^{-11}
	Th natural	S	6×10^{-11}	6×10^{-11}	2×10^{-11}	3×10^{-11}
		I	6×10^{-11}	6×10^{-11}	2×10^{-11}	3×10^{-11}
		I	6×10^{-11}	6×10^{-11}	2×10^{-11}	3×10^{-11}
		I	6×10^{-11}	6×10^{-11}	2×10^{-11}	3×10^{-11}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Thorium (90)	Th 234	S	6×10^{-7}	8×10^{-4}	2×10^{-9}	2×10^{-7}
	I	I	3×10^{-7}	5×10^{-4}	1×10^{-9}	2×10^{-7}
Thorium (69)	Th 170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-7}
	I	I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-7}
	Th 171	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	5×10^{-7}
	I	I	2×10^{-7}	1×10^{-3}	5×10^{-9}	5×10^{-7}
Tin (50)	Sn 113	S	4×10^{-7}	2×10^{-3}	1×10^{-9}	9×10^{-7}
	I	I	5×10^{-7}	2×10^{-3}	2×10^{-9}	8×10^{-7}
	Sn 123	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-7}
	I	I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-7}
Tungsten (Wolfram) (74)	W 181	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-7}
	I	I	1×10^{-7}	1×10^{-3}	4×10^{-9}	3×10^{-7}
	W 183	S	8×10^{-7}	4×10^{-3}	3×10^{-9}	1×10^{-7}
	I	I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-7}
	W 187	S	4×10^{-7}	2×10^{-3}	2×10^{-9}	7×10^{-7}
	I	I	3×10^{-7}	2×10^{-3}	1×10^{-9}	6×10^{-7}
Uranium (92)	U 230	S	3×10^{-10}	1×10^{-4}	1×10^{-11}	8×10^{-9}
	I	I	1×10^{-10}	1×10^{-4}	4×10^{-11}	5×10^{-9}
	U 232	S	1×10^{-10}	8×10^{-4}	3×10^{-11}	2×10^{-9}
	I	I	3×10^{-11}	8×10^{-4}	9×10^{-11}	3×10^{-9}
	U 233	S	5×10^{-10}	2×10^{-4}	2×10^{-11}	3×10^{-9}
	I	I	1×10^{-10}	9×10^{-4}	4×10^{-11}	2×10^{-9}
ee U 234	S	S	6×10^{-10}	9×10^{-4}	2×10^{-11}	2×10^{-9}
	I	I	1×10^{-10}	9×10^{-4}	6×10^{-11}	2×10^{-9}
ee U 235	S ⁴	S ⁴	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-9}
	I	I	1×10^{-10}	8×10^{-4}	4×10^{-11}	3×10^{-9}
	U 236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	2×10^{-9}
	I	I	1×10^{-10}	1×10^{-3}	4×10^{-11}	2×10^{-9}
ee U 238	S ⁴	S ⁴	7×10^{-11}	1×10^{-3}	2×10^{-11}	4×10^{-9}
	I	I	1×10^{-10}	1×10^{-3}	8×10^{-11}	4×10^{-9}
	U 240	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-7}
	I	I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-7}
ee U-natural	S ⁴	S ⁴	1×10^{-10}	1×10^{-3}	3×10^{-11}	3×10^{-9}
	I	I	1×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-9}
Vanadium (23)	V 48	S	2×10^{-7}	9×10^{-4}	4×10^{-9}	3×10^{-7}
	I	I	6×10^{-8}	8×10^{-4}	2×10^{-9}	2×10^{-7}
Xenon (54)	Xe 121m	Sub	2×10^{-7}		4×10^{-7}	
	Xe 123	Sub	1×10^{-7}		3×10^{-7}	
	Xe 133m	Sub	1×10^{-7}		3×10^{-7}	
	Xe 135	Sub	4×10^{-7}		1×10^{-7}	
Ytterbium (70)	Yb 173	S	7×10^{-7}	3×10^{-3}	2×10^{-9}	1×10^{-7}
	I	I	4×10^{-7}	3×10^{-3}	2×10^{-9}	1×10^{-7}
Yttrium (39)	Y 90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-7}
	I	I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-7}
	91m	S	2×10^{-7}	1×10^{-1}	8×10^{-7}	3×10^{-7}
	I	I	2×10^{-7}	1×10^{-1}	4×10^{-7}	3×10^{-7}
	Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-7}
	I	I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-7}
	Y 92	S	4×10^{-7}	9×10^{-4}	1×10^{-9}	6×10^{-7}
	I	I	3×10^{-7}	9×10^{-4}	1×10^{-9}	6×10^{-7}
	Y 93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-7}
	I	I	1×10^{-7}	8×10^{-4}	5×10^{-9}	2×10^{-7}

25 FR 10914

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

Element (atomic number)	Isotope ¹	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)
Zinc (30)	Zn 65	1×10^{-7}	3×10^{-7}	4×10^{-7}	1×10^{-7}
	Zn 66	6×10^{-7}	3×10^{-7}	3×10^{-7}	2×10^{-7}
	Zn 67m	4×10^{-7}	2×10^{-7}	1×10^{-7}	7×10^{-7}
	Zn 68	3×10^{-7}	2×10^{-7}	1×10^{-7}	6×10^{-7}
	Zn 69	7×10^{-7}	5×10^{-7}	2×10^{-7}	2×10^{-7}
Zirconium (40)	Zr 93	1×10^{-7}	3×10^{-7}	4×10^{-7}	6×10^{-7}
	Zr 94	3×10^{-7}	3×10^{-7}	1×10^{-7}	6×10^{-7}
	Zr 95	1×10^{-7}	2×10^{-7}	1×10^{-7}	6×10^{-7}
	Zr 96	3×10^{-7}	2×10^{-7}	1×10^{-7}	6×10^{-7}
	Zr 97	1×10^{-7}	3×10^{-7}	4×10^{-7}	2×10^{-7}
Sub		1×10^{-7}	3×10^{-7}	3×10^{-7}	2×10^{-7}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours		3×10^{-7}	9×10^{-7}	1×10^{-7}	3×10^{-7}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours		6×10^{-7}	4×10^{-7}	2×10^{-7}	3×10^{-7}
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission					

¹Soluble (S); insoluble (I)²Sub: means that values given are for submersion in a homogeneous infinite cloud of airborne radionuclides.

* These radon concentrations are appropriate for protection from radon-222 combined with its short-lived daughters. Alternatively, the value in Table I may be replaced by one-third ($\frac{1}{3}$) "working level." (A "working level" is defined as any combination of short-lived radon-222 daughters, polonium-218, lead-214, bismuth-214 and polonium-214, in one liter of air, without regard to the degree of equilibrium, that will result in the ultimate emission of 1.3×10^5 MeV of alpha particle energy.) The Table II value may be replaced by one-thirtieth ($\frac{1}{30}$) of a "working level." The limit on radon-222 concentrations in restricted areas may be based on an annual average.

14. For soluble mixtures of U-238, U-234 and U-235 in air chemical toxicity may be the limiting factor. If the percent by weight (enrichment) of U-235 is less than 5, the concentration value for a 40-hour workweek, Table I, is 0.3 milligrams uranium per cubic meter of air average. For any enrichment, the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed 5×10^{-4} SA $\mu\text{Ci-hr/ml}$, where SA is the specific activity of the uranium isotope. The concentration value for Table II is 0.007 milligrams uranium per cubic meter of air. The specific activity for natural uranium is 9.77×10^{-4} curies per gram U. The specific activity for other mixtures of U-238, U-234 and U-235, if not known, shall be:

$$SA = 5.8 \times 10^{-4} \text{ curies/gram U} \quad \text{U-depleted}$$

$$SA = (0.4 + 0.38 X + 0.0084 Y) \times 10^{-4} \text{ SA} \quad X \geq 2.7$$

where X is the percentage by weight of U-235, Y is the percentage by weight of U-238.

* Amended 37 FR 23319.

** Amended 39 FR 23990; footnote redesignated 40 FR 50704.

*** Amended 40 FR 50704.

† Amended 38 FR 29314.

‡ Amended 39 FR 25463; redesignated 40 FR 50704.

NOTE TO APPENDIX B

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations C_A , C_B , and C_C , and if the applicable MPC's are MPC_A , MPC_B , and MPC_C , respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \frac{C_C}{MPC_C} \leq 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting value for purposes of Appendix B shall be:

- For purposes of Table I, Col. 1— 5×10^{-6}
- For purposes of Table I, Col. 2— 4×10^{-6}
- For purposes of Table II, Col. 1— 3×10^{-6}
- For purposes of Table II, Col. 2— 3×10^{-6}

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in paragraph 2 above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Appendix "B" for the radionuclide in the mixture having the lowest concentration limit; or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Appendix "B" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix "B" for any radionuclide which is not known to be absent from the mixture; or

c. Element (atomic number) and isotopes	Table I		Table II	
	Column 1 Air ($\mu\text{Ci}/\text{ml}$)	Column 2 Water ($\mu\text{Ci}/\text{ml}$)	Column 1 Air ($\mu\text{Ci}/\text{ml}$)	Column 2 Water ($\mu\text{Ci}/\text{ml}$)
If it is known that Sr 90, I 125, I 126, I 129, I 131, (I 133, table II only), Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th 234, Cm 244, Cf 254, and Fm 257 are not present.....		5×10^{-6}		5×10^{-6}
If it is known that Sr 90, I 125, I 126, I 129, I 131, I 133, table II only, Pb 210, Po 210, Ra 223, Ra 224, Ra 226, Pa 231, Th 232, Cm 244, Cf 254, and Fm 257 are not present.....		5×10^{-6}		5×10^{-6}
If it is known that Sr 90, I 125, I 126, I 131, table II only, Pb 210, Ra 226, Ra 228, Cm 244, and Cf 254 are not present.....		5×10^{-6}		5×10^{-6}
If it is known that (I 129, table II only), Ra 226, and Ra 228 are not present.....		5×10^{-6}		1×10^{-6}
If it is known that alpha-emitters and Sr 90, I 126, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Ua 246 are not present.....	5×10^{-6}		1×10^{-6}	
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present.....	5×10^{-6}		1×10^{-6}	
If it is known that alpha-emitters and Ac 227 are not present.....	5×10^{-6}		1×10^{-6}	
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 244, Cf 249, and Cf 251 are not present.....	5×10^{-6}		1×10^{-6}	

4. If a mixture of radionuclides consists of uranium and its daughters in ore dust prior to chemical separation of the uranium from the ore, the values specified below may be used for uranium and its daughters through radium-226, instead of those from paragraphs 1, 2, or 3 above.

a. For purposes of Table I, Col. 1— 1×10^{-6} $\mu\text{Ci}/\text{ml}$ gross alpha activity; or 5×10^{-6} $\mu\text{Ci}/\text{ml}$ natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1— 5×10^{-6} $\mu\text{Ci}/\text{ml}$ gross alpha activity; or 5×10^{-6} $\mu\text{Ci}/\text{ml}$ natural uranium; or 5 micrograms per cubic meter of air natural uranium.

5. For purposes of this Note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_A) to the concentration limit for that radionuclide specified in Table II of Appendix B (MPC_A) does not exceed $\frac{1}{10}$

(i.e., $\frac{C_A}{MPC_A} \leq \frac{1}{10}$) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed $\frac{1}{10}$

$$\text{i.e., } \frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \dots \leq \frac{1}{10}$$

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Material	Microcuries
Americium-241	100
Antimony-122	10
Antimony-124	10
Antimony-125	10
Arsenic-73	100
Arsenic-74	10
Arsenic-76	10
Arsenic-77	100
Barium-131	10
Barium-134	10
Bismuth-210	10
Bromine-82	10
Cadmium-109	10
Cadmium-115m	10
Cadmium-116	100
Calcium-45	10
Calcium-47	10
Carbon-14	100
Cerium-141	100
Cerium-143	100
Cerium-144	100
Cesium-131	1,000
Cesium-134m	100
Cesium-134	10
Cesium-135	10
Cesium-136	10
Cesium-137	10
Chlorine-36	10
Chlorine-38	10
Chromium-51	1,000
Cobalt-58m	10
Cobalt-59	10
Cobalt-60	10
Copper-64	100
Dysprosium-155	10
Dysprosium-166	100
Erbium-169	100
Erbium-171	100
Europium-152 9.3 h.	1
Europium-152 13 yr.	1
Europium-154	10
Europium-155	10
Fluorine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	100
Gold-198	100
Gold-199	100
Hafnium-181	100
Holmium-166	1,000
Hydrogen-3	1,000
Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	1
Iodine-131	10
Iodine-132	10
Iodine-133	10
Iodine-134	10
Iodine-135	10
Iridium-192	100
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	10
Krypton-87	10
Lanthanum-140	100
Lawrencium-103	10
Manganese-52	10
Manganese-54	10
Manganese-56	10
Mercury-197m	100
Mercury-197	100
Mercury-203	10
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	10
Nickel-63	100
Nickel-65	10
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10

Material	Microcuries
Cesium-137m	100
Cesium-137	100
Cesium-138	100
Palladium-103	100
Palladium-106	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	10
Polonium-210	10
Potassium-42	10
Praseodymium-143	100
Praseodymium-145	100
Promethium-147	10
Promethium-149	10
Radium-226	100
Rhenium-186	100
Rhenium-188	100
Rhodium-105m	100
Rhodium-106	100
Rubidium-87	10
Ruthenium-99	100
Ruthenium-100	10
Ruthenium-101	10
Ruthenium-102	10
Samarium-151	100
Samarium-153	100
Scandium-46	10
Scandium-47	100
Scandium-48	10
Selenium-75	10
Silicon-31	100
Silver-106	10
Silver-110m	10
Silver-111	10
Sodium-24	10
Strontium-85	10
Strontium-89	10
Strontium-90	10
Strontium-91	10
Strontium-92	10
Sulphur-35	100
Tantalum-182	10
Technetium-96	100
Technetium-97m	100
Technetium-97	100
Technetium-99m	10
Technetium-99	10
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	100
Tellurium-129m	10
Tellurium-129	100
Tellurium-131m	10
Tellurium-132	10
Terbium-160	100
Thallium-200	100
Thallium-201	100
Thallium-202	10
Thallium-204	100
Thorium (natural)	10
Thulium-170	10
Thulium-171	10
Tin-113	10
Tin-125	10
Tungsten-181	10
Tungsten-185	100
Tungsten-187	100
Uranium (natural)	100
Uranium-233	10
Uranium-234	10
Uranium-235	10
Vanadium-48	1,000
Xenon-133m	100
Xenon-133	100
Xenon-135	100
Ytterbium-173	100
Yttrium-90	10
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zirconium-93	10
Zirconium-95	10
Zirconium-97	10

Any alpha emitting radionuclides not listed above or mixtures of alpha emitters of unknown composition 01

Any radionuclides other than alpha emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition 1

Note.—For purposes of § 20.203, where there is involved a combination of isotopes in known amounts, the limit for the combination should be derived as follows. Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i.e., "unity").

¹ Based on alpha disintegration rate of Th-232, Th-230 and their daughter products.

² Based on alpha disintegration rate of U-238, U-234, and U-235.

* Amended 36 FR 16848

** Amended 39 FR 23490

PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

APPENDIX D—UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICES

50 FR 46630

	Addresses	Telephone (24 hours)
Region I: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.	USNRC, 831 Park Avenue, King of Prussia, PA 19405	(215) 337-8000 (FTS) 488-1000
Region II: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia.	USNRC, 101 Marietta Street, NW, Suite 2900, Atlanta, GA 30323	(404) 331-4503 (FTS) 242-4803
Region III: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.	USNRC, 799 Roosevelt Road, Glen Ellyn, IL 60137	(312) 790-5500 (FTS) 388-5500
Region IV: Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming.	USNRC, 811 Ryan Plaza Drive, Suite 1000, Arlington, TX 78011	(817) 890-8100 (FTS) 728-8100
Region IV Field Office	USNRC, Region IV Uranium Recovery Field Office, 730 Emma Street, P.O. Box 25325, Denver, CO 80225	(303) 234-7232 (FTS) 234-723
Region V: Alaska, Arizona, California, Hawaii, Nevada, Oregon, Pacific Trust Territories, and Washington.	USNRC, 1450 Marin Lane, Suite 210, Walnut Creek, CA 94596	(415) 943-31 (FTS) 483-3

UNITED STATES NUCLEAR REGULATORY COMMISSION
RULES and REGULATIONS

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

§ 19.1

**PART
19**

**NOTICES, INSTRUCTIONS, AND REPORTS TO WORKERS;
INSPECTIONS**

§ 19.12

40 FR 8774

19.1 Purpose.
19.2 Scope.
19.3 Definitions.
19.4 Interpretations.
19.5 Communications.
19.6 Information collection requirements: OMB approval.
19.11 Posting of notices to workers.
19.12 Instructions to workers.
19.13 Notifications and reports to individuals.
19.14 Presence of representatives of licensees and workers during inspections.
19.15 Consultation with workers during inspections.
19.16 Requests by workers for inspections.
19.17 Inspections not warranted; informal review.
19.30 Violations.
19.31 Application for exemptions.
19.32 Discrimination prohibited.
Authority: Secs. 53, 63, 71, 103, 104, 161, 186, 88 Stat. 930, 933, 935, 936, 937, 948, 955, as amended; sec. 234, 83 Stat. 444, as amended (42 U.S.C. 2073, 2083, 2111, 2133, 2134, 2201, 2236, 2282); sec. 301, 88 Stat. 1242, as amended by Pub. L. 94-79, 88 Stat. 433 (42 U.S.C. 5841); Pub. L. 95-601, sec. 10, 92 Stat. 3051 (42 U.S.C. 5851).
For the purposes of sec. 223, 88 Stat. 956, as amended (42 U.S.C. 2273): §§ 19.11(a), (c), (d), and (e) and 19.12 are issued under sec. 161b, 88 Stat. 948, as amended (42 U.S.C. 2201(b)); and §§ 19.13 and 19.14(a) are issued under sec. 1310, 88 Stat. 950, as amended (42 U.S.C. 2201(c)).

§ 19.1 Purpose.

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

§ 19.2 Scope.

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

§ 19.3 Definitions.

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

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

§ 19.4 Interpretations.

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

§ 19.5 Communications.

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

§ 19.6 Information collection requirements: OMB approval.

(a) The Nuclear Regulatory Commission has submitted the information collection requirements contained in this part to the Office of Management and Budget (OMB) for approval as required by the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 et seq.). OMB has approved the information collection requirements contained in this part under control

number 3150-0044.

(b) The approved information collection requirements contained in this part appear in § 19.13.

§ 19.11 Posting of notices to workers.

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

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

(c) Each licensee and applicant shall post Form NRC-3, (Revision 8-82 or later) "Notice to Employees," as required by Parts 30, 40, 50, 60, 70, 72, and 150 of this chapter.

NOTE: Copies of Form NRC-3 may be obtained by writing to the Director of the appropriate U.S. Nuclear Regulatory Commission Inspection and Enforcement Regional Office listed in Appendix "D", Part 20 of this chapter, or the Director, Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

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

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

§ 19.12 Instructions to workers.

All individuals working in or frequenting any portion of a restricted area shall be kept informed of the storage, transfer, or use of radioactive materials or of radiation in such portions of the restricted area; shall be instructed in the health protection problems associated

PART 19 • NOTICES, INSTRUCTIONS, AND REPORTS TO WORKERS; INSPECTIONS

with exposure to such radioactive materials or radiation, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed; shall be instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of Commission regulations and licenses for the protection of personnel from exposures to radiation or radioactive materials occurring in such areas; shall be instructed of their responsibility to report promptly to the licensee any condition which may lead to or cause a violation of Commission regulations and licenses or unnecessary exposure to radiation or to radioactive material; shall be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and shall be advised as to the radiation exposure reports which workers may request pursuant to § 19.13. The extent of these instructions shall be commensurate with potential radiological health protection problems in the restricted area.

§ 19.13 Notifications and reports to individuals.

(a) Radiation exposure data for an individual, and the results of any measurements, analyses, and calculations of radioactive material deposited or retained in the body of an individual, shall be reported to the individual as specified in this section. The information reported shall include data and results obtained pursuant to Commission regulations, orders or license conditions, as shown in records maintained by the licensee pursuant to Commission regulations. Each notification and report shall: be in writing; include appropriate identifying data such as the name of the licensee, the name of the individual, the individual's social security number; include the individual's exposure information; and contain the following statement:

This report is furnished to you under the provisions of the Nuclear Regulatory Commission regulation 10 CFR Part 19. You should preserve this report for further reference.

(b) At the request of any worker, each licensee shall advise such worker annually of the worker's exposure to radiation or radioactive material as shown in records maintained by the licensee pursuant to § 20.401(a) and (c).

(c) At the request of a worker formerly engaged in licensed activities controlled by the licensee, each licensee shall furnish to the worker a report of the worker's exposure to radiation or radioactive material. Such report shall be furnished within 30 days from the time the request is made, or within 30 days after the exposure of the individual has been determined by the licensee, whichever is later; shall cover, within the period of time specified in the request, each calendar quarter in which the worker's activities involved exposure to radiation from radioactive materials licensed by the Commission; and shall include the dates and locations of licensed activities in which the worker participated during this period.

(d) When a licensee is required pursuant to § 20.405 or § 20.408 of this chapter to report to the Commission any exposure of an individual to radiation or radioactive material the licensee shall also provide the individual a report on his exposure data included therein. Such report shall be transmitted at a time not later than the transmittal to the Commission.

(e) At the request of a worker who is terminating employment in a given calendar quarter with the licensee in work involving radiation dose, or of a worker who, while employed by another person, is terminating assignment to work involving radiation dose in the licensee's facility in that calendar quarter, each licensee shall provide to each such worker, or to the worker's designee, at termination, a written report regarding the radiation dose received by that worker from operations of the licensee during that specifically identified calendar quarter or fraction thereof, or provide a written estimate of that dose if the finally determined personnel monitoring results are not available at that time. Estimated doses shall be clearly indicated as such.

§ 19.14 Presence of representatives of licensees and workers during inspections.

(a) Each licensee shall afford to the Commission at all reasonable times opportunity to inspect materials, activities, facilities, premises, and records pursuant to the regulations in this chapter.

(b) During an inspection, Commission inspectors may consult privately with workers as specified in § 19.15. The licensee or licensee's representative may accompany Commission inspectors during other phases of an inspection.

(c) If, at the time of inspection, an individual has been authorized by the workers to represent them during Commission inspections, the licensee shall notify the inspectors of such authorization and shall give the workers' representative an opportunity to accompany the inspectors during the inspection of physical working conditions.

(d) Each workers' representative shall be routinely engaged in licensed activities under control of the licensee and shall have received instructions as specified in § 19.12.

(e) Different representatives of licensees and workers may accompany the inspectors during different phases of an inspection if there is no resulting interference with the conduct of the inspection. However, only one workers' representative at a time may accompany the inspectors.

(f) With the approval of the licensee and the workers representative an individual who is not routinely engaged in licensed activities under control of the licensee, for example, a consultant to the licensee or to the workers' representative, shall be afforded the opportunity to accompany Commission inspectors during the inspection of physical working conditions.

(g) Notwithstanding the other provisions

of this section, Commission inspectors are authorized to refuse to permit accompaniment by any individual who deliberately interferes with a fair and orderly inspection. With regard to areas containing information classified by an agency of the U.S. Government in the interest of national security, an individual who accompanies an inspector may have access to such information only if authorized to do so. With regard to any area containing proprietary information, the workers' representative for that area shall be an individual previously authorized by the licensee to enter that area.

§ 19.15 Consultation with workers during inspections.

(a) Commission inspectors may consult privately with workers concerning matters of occupational radiation protection and other matters related to applicable provisions of Commission regulations and licenses to the extent the inspectors deem necessary for the conduct of an effective and thorough inspection.

(b) During the course of an inspection any worker may bring privately to the attention of the inspectors, either orally or in writing, any past or present condition which he has reason to believe may have contributed to or caused any violation of the act, the regulations in this chapter, or license condition, or any unnecessary exposure of an individual to radiation from licensed radioactive material under the licensee's control. Any such notice in writing shall comply with the requirements of § 19.16(a).

(c) The provisions of paragraph (b) of this section shall not be interpreted as authorization to disregard instructions pursuant to § 19.12.

§ 19.16 Requests by workers for inspections.

(a) Any worker or representative of workers who believes that a violation of the Act, the regulations in this chapter, or license conditions exists or has occurred in license activities with regard to radiological working conditions in which the worker is engaged, may request an inspection by giving notice of the alleged violation to the Director of Inspection and Enforcement, to the Director of the appropriate Commission Regional Office, or to Commission inspectors. Any such notice shall be in writing, shall set forth the specific grounds for the notice, and shall be signed by the worker or representative of workers. A copy shall be provided the licensee by the Director of Inspection and Enforcement, Regional Office Director, or the inspector no later than at the time of inspection except that, upon the request of the worker giving such notice, his name and the name of individuals referred to therein shall not appear in such copy or on any record published, released, or made available by the Commission, except for good cause shown.

(b) If, upon receipt of such notice, the Director of Inspection and Enforcement or Regional Office Director determines that the complaint meets the requirements set forth in paragraph (a) of this section, and that there are reasonable grounds to believe that the alleged violation exists or has occurred, he shall cause an inspection to be made as soon as practicable, to determine if such alleged violation exists or has occurred. Inspections pur-

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suant to this section need not be limited to matters referred to in the complaint.

§ 19.17 Inspections not warranted; informal review.

(a) If the Director of Inspection and Enforcement or of the appropriate Regional

Office determines, with respect to a complaint under § 19.16, that an inspection is not warranted because there are no reasonable grounds to believe that a violation exists or has occurred, he shall notify the complainant in writing of such determination. The complainant may obtain review of such determination by submitting a written statement of position with the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, who will provide the licensee with a copy of such statement by certified mail, excluding, at the request of the complainant, the name of the complainant. The licensee may submit an opposing written statement of position with the Executive Director for Operations who will provide the complainant with a copy of such statement by certified mail. Upon the request of the complainant, the Executive Director for Operations or his designee may

hold an informal conference in which the complainant and the licensee may orally present their views. An informal conference may also be held at the request of the licensee, but disclosure of the identity of the complainant will be made only following receipt of written authorization from the complainant. After considering all written and oral views presented, the Executive Director for Operations shall affirm, modify, or reverse the determination of the Director of Inspection and Enforcement or of the appropriate Regional Office and furnish the complainant and the licensee a written notification of his decision and the reason therefor.

(b) If the Director of Inspection and Enforcement or of the appropriate Regional Office determines that an inspection is not warranted because the requirements of § 19.16(a) have not been met, he shall notify the complainant in writing of such determination. Such determination shall be without prejudice to the filing of a new complaint meeting the requirements of § 19.16(a).

§ 19.20 Employee protection.

Employment discrimination by a licensee or a contractor or subcontractor of a licensee against an employee for engaging in protected activities under this part or Parts 30, 40, 50, 60, 70, 72, or 150 of this chapter is prohibited.

§ 19.30 Violations.

An injunction or other court order may be obtained prohibiting any violation of any provision of the Act or Title II of the Energy Reorganization Act of 1974, or any regulation or order issued thereunder.

A court order may be obtained for the payment of a civil penalty imposed pursuant to section 23 of the Act for violation of section 53, 57, 62, 63, 81, 82, 101, 103, 104, 107, or 109 of the Act or any rule, regulation, or order issued thereunder, or any term, condition or limitation of any license issued thereunder, or for any violation for which a license may be revoked under section 186 of the Act. Any person who willfully violates any provision of the Act or any regulation or order issued thereunder may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

§ 19.31 Application for exemptions.

The Commission may, upon application by any licensee or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not result in undue hazard to life or property.

§ 19.32 Discrimination prohibited.

No person shall on the ground of sex be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity licensed by the Nuclear Regulatory Commission. This provision will be enforced through agency provisions and rules similar to those already established, with respect to racial and other discrimination, under title VI of the Civil Rights Act of 1964. This remedy is not exclusive, however, and will not prejudice or cut off any other legal remedies available to a discriminatee.

BETWEEN: William O. Miller, Chief
License Fee Management Branch
Office of Administration

John E. Glenn, Chief
Nuclear Materials Section B
Division of Engineering and
Technical Programs

(14) 9/15

030-30152

LICENSE FEE TRANSMITTAL

A. REG ON I

1. APPLICATION ATTACHED

Applicant/Licensee:

Eni Chem Americas, Inc.

Application Dated:

7/22/87

Control No.:

107635

License No.:

New

2. FEE ATTACHED

Amount:

\$ 700.00

Check No.:

105

3. COMMENTS

Signed

[Signature]

Date

8/6/87

B. LICENSE FEE MANAGEMENT BRANCH

1. Fee Category and Amount:

3M

\$ 700

2. Correct Fee Paid. Application may be processed for:

Amendment _____

Renewal _____

License ✓ _____

Signed

[Signature]

Date

8/10/87