Technical Report Documentation Page

1. REPORT No.

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE

Safety Manual for Administrative Instructions to Radiographic Personnel

5. REPORT DATE

May 1963

6. PERFORMING ORGANIZATION

7. AUTHOR(S)

Paul G. Jonas

8. PERFORMING ORGANIZATION REPORT No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS

State of California
Department of Public Works
Division of Highways
Materials and Research Department

10. WORK UNIT No.

11. CONTRACT OR GRANT No.

13. TYPE OF REPORT & PERIOD COVERED

12. SPONSORING AGENCY NAME AND ADDRESS

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Introduction

The purpose of this manual is to serve as a guide for Radiographic Personnel and to be used throughout the Division of Highways for the express purpose of regulating radiographic inspection of welded structural steel for bridges and buildings.

17. KEYWORDS

18. No. OF PAGES:

114

19. DRI WEBSITE LINK

http://www.dot.ca.gov/hq/research/researchreports/1961-1963/63-24.pdf

20. FILE NAME

63-24.pdf

0219

B-3

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

SAFETY MANUAL

FOR

ADMINISTRATIVE INSTRUCTIONS TO

RADIOGRAPHIC PERSONNEL

May 1963

63-24
DND

63-24

DND

State of California
Department of Public Works
Division of Highways
Materials and Research Department

SAFETY MANUAL

FOR

ADMINISTRATIVE INSTRUCTIONS TO

RADIOGRAPHIC PERSONNEL

F. N. Hveem
Materials and Research Engineer

Prepared by:

Paul G. Jonas, Welding Engineer
Structural Materials Section

May 1963

INTRODUCTION

The purpose of this manual is to serve as a guide for Radiographic Personnel and to be used throughout the Division of Highways for the express purpose of regulating radiographic inspection of welded structural steel for bridges and buildings.

All radiographic technicians responsible for radioactive sources shall be:

1. Thoroughly familiar with the safe handling techniques of radioactive sources.

2. Fully informed of the hazards to health that exist near radioactive sources.

3. Completely familiar and comply with the following rules and regulations:

   a. General Safety Orders, Group 6, Article 53 of the State Division of Industrial Safety.

   b. Federal Register Title 10, Chapter 1, Parts 20, 30, and 31 as amended through September 7, 1960.

   c. Structural Materials Laboratory Safety Manual for Administrative Instructions to Radiographic Personnel.

   d. State of California, Department of Public Health, Title 17 (Register 62, No. 1-1-20-62) and Division 20.

A. The only qualified personnel who will personally supervise the use of sealed sources and who will be in continuous attendance at the site of use are:

Paul G. Jonas
Charles B. Kendrick
Robert G. Milliron
John Ribarchik

No other personnel or radiographers assistants will be used.

B. Mr. Paul G. Jonas will be directly responsible for the over-all radiation protection program. He will be assisted by Mr. Kendrick, who will assume all of Mr. Jonas' responsibilities in his absence.

The above personnel have been trained in accordance with the requirements in Appendix A by attending approved A.E.C. courses in health physics and radiation safety. Copies of their attendance certificates for these courses are on file with the A.E.C. and additional copies are included in this manual.

C. The California Division of Highways Safety Section has assigned the radiation protection officers to insure that the following directives are observed:

1. To stop or suspend any operation which does not comply with the current Federal Register Title 10, Part 20 as amended through September 7, 1960, Standards for protection against radiation or Federal Register Title 10, Chapter 2, Parts 30 and 31, Radiation Safety Requirements for Radiographic operations, dated November 29, 1960; the State Safety Orders, Group 6, Article 53, of the State Division of Industrial Safety; Division 20 of the California Health & Safety Code and Title 17 of the California Administrative Code; and future amendments of each of the above.

2. Insist that only safe working conditions be practiced and maintained.

3. Inspect all safety, dosage, and medical reports for compliance.

4. Insist that leak tests are performed when required every six months.

5. Insist that proper leak testing, repairs, tagging, modification, replacement and disposal of sources are done only by persons especially authorized to do so.

6. Maintain a quarterly inventory record of strength, type and date of measurement of each source. He shall see that a utilization log is made for each job which records the make and model number of exposure device, or description of storage container and type and strength of source contained

therein. The utilization log shall identify the radiographer, schedule and location and date of use. A record of a final survey to ascertain that source is stored shall also be recorded.

7. All survey instruments shall be at all times in good working condition. The instruments shall be calibrated at intervals of not to exceed three months and shall also be calibrated after each repair.

8. To assist in emergency recovery of lost radioactive materials.

These officers will be assisted by Mr. C. B. Kendrick, who will also be assigned as the radiation protection officer for Structural Materials Section of the Materials and Research Department.

SUPERVISION

D. 1. All operations involving exposure to radiation shall be under the direct supervision of qualified personnel familiar with hazards of exposure to such radiation as may be encountered.

2. In the use of radioactive materials, the radiographic technician will be responsible for monitoring the area and determining radiation intensity.

3. The radiographic technician will make a layout of the radiation field for the record. See Figure II and IIa.

4. Only those employees who are Radiographers or Radiation Protection Officers and directly involved in the use of such radiation shall be permitted access to radiation levels which, if an individual were continuously present, would result in his receiving a dose in excess of 2 millirems in any one hour or 500 millirems in one year. (See Section 30268 Title 17).

5. No person shall be permitted access to radiation levels which if an individual were continuously present would result in his receiving a dose in excess of 100 millirems in any seven consecutive days. (Except in emergency recovery of radioactive material by a licensed technician.) (See Section 30268 Title 17)

6. No one shall be permitted to enter a radiation field of greater intensity than 0.5 roentgens per hour.

7. No person shall be allowed to enter a radiation field without carrying a properly operating rate-indicating survey meter.

8. The maximum allowable radiation dosage to the radiographic technician is established at 100 mr per week or 20 mr per day.

9. When using buildings or property as a site for use or storage, the supervisor shall insure that persons responsible for the property are aware of the radiation hazard.

TRAINING COURSE OUTLINE

E. The radiographic technicians who will personally be working with the Sealed Sources are:

Paul G. Jonas
Charles B. Kendrick
Robert G. Milliron
John Ribarchik

No other personnel or Radiographers' Assistants will be used.

The above personnel have been trained in accordance to the approved A.E.C. course in Health Physics and Radiation Safety per Appendix A and their certificate "copy" on file with A.E.C. Byproduct Licensing Branch. A copy of each of these certificates is included in this manual.

APPENDIX A

I. Fundamentals of radiation safety:

A. Characteristics of Gamma Radiation.

B. Units of radiation dose (mrem) and quantity of radioactivity (curie).

C. Hazards of excessive exposure of radiation.

D. Levels of radiation from licensed material.

E. Methods of controlling radiation dose.

1. Working time.

2. Working distances.

3. Shielding

II. Radiation detection instrumentation to be used:

A. Use of radiation survey instruments:

1. Operation.

2. Calibration.

3. Limitations.

B. Survey Techniques.

C. Use of personnel monitoring equipment:

1. Film badges

2. Pocket dosimeters.

3. Pocket chambers

III. Radiographic equipment to be used:

A. Remote handling equipment.

B. Radiographic exposure devices.

C. Storage containers.

IV. The requirements of pertinent Federal Regulations.

V. The licensee's written operating and emergency procedures.

F. Instruction to Personnel Concerning the Safe Operation of Radiographic Exposure Devices.

1. Cobalt 60 one curie source, open air radiography.

2. Kel-Ray Projector Model C-B, with 20 curie cesium 137 source.

3. Curtiss-Wright Puff Camera Model 10-5A with 30 curie iridium 192 source.

4. The personnel working with the foregoing radiographic exposure devices will not receive in excess of 100 mr per week. Our experience has shown in the past the 100 mr per week standard is well within our exposure limit.

G. Cobalt 60 Source Safe Handling Procedure.

1. The cobalt source is the standard CR-1000 Tracerlab model. The source is equipped with a permanent identification tag attached to the handling chain.

2. The storage container for the one curie cobalt 60 source is the Type E-33 container Tracerlab model. The container has a 5 inch wall thickness of lead encompassing the source cavity and weighs 270 pounds. This container will be bracketed into the truck and locked with a key for transportation and storage. The container is also labelled showing the type and amount of radiation.

3. The handling of the cobalt 60 source will be limited and employed only as a last resort. Every effort must be exerted to use the iridium 192 or the Kel-Ray cesium 137 projector.

4. The handling of the one curie cobalt 60 source will be the standard open air fishpole technique. (Two methods used.)

First Method: The fishpole is a 10-foot handler equipped with mechanical fingers for positive handling between storage container and radiographic setup or from the storage container to a safety carrying pot for work done at great heights above the ground.

Second Method: A fishpole handler 10-foot in length is fashioned with a hook and the source is hooked by the handling chain and lifted from the storage container to the radiographic setup, or, as above, from a safety carrying pot.

The methods of handling must be determined in advance in accordance with the rules and regulations of the Federal Register.

Note: For both fishpole technique handling methods, there shall be a safety cord with one end attached to the source handling chain and the other end of the safety cord secured to the grip-end of the fishpole. This is to insure immediate recovery in case source is dropped. The safety cord end, which is attached to the grip-end of the fishpole, shall be fastened with a versatile hook which will enable the radiographic technician to secure the end of the safety cord to a magnet placed near the radiographic exposure setup.

5. Identification tags or other attachments relating to the source capsule to be used outside the source holder will be secured by licensed laboratories equipped to handle such sources at close range; and likewise, all repairs or replacements of such tags or similar attachments will be handled by such laboratories through a contracted service agreement.

H. Characteristics and Methods of Operation of Kel-Ray Projector Model C-B with 20 Curie Cesium 137 Source.

1. Prior to actual operation of the Kel-Ray Projector, the technician shall study the Kel-Ray handbook whereby he shall acquire a thorough knowledge of the projector operation and become familiar with nomeclature of parts.

I. Curtiss-Wright Model 10-5A Iridium Puff Camera with 30 Curie Iridium 192 Source, Characteristics and Methods of Operation.

Here also the technician shall study the Curtiss-Wright operation manual for the 10-5A puff camera and become thoroughly versed in the operation, parts, and their designated names.

J. Radiation Survey Instrumentation.

1. The radiographic technician shall make a physical radiation survey at the jobsite when radiographic exposures are being made to determine the level of radiation.

2. The types of survey instruments which are at the radiographic technician's disposal are as follows:

(Type of Survey Meters)	(Sensitivity Range-mr/hr)		
(1) Victoreen Gamma Survey Meter #592	(0-10)	(0-100)	(0-1000)
(2) Tracerlab SU-1H Survey Meter	(0-15)	(0-150)	(0-1500)
(3) Tracerlab SU-14 Survey Meter	(0-25)	(2.5)	(25.0)

Instrument 1 or 2 must be used by the technician at the jobsite at all times.

3. All of the Survey Meters #1, #2, and #3 must be calibrated and checked at regular intervals and kept in good operating condition.

4. The calibration and checking of the survey meters shall be done by the manufacturer or qualified laboratories and the date recorded on the meter.

5. It is required that an actual physical radiation survey be made to determine compliance with Section 30293, Title 17 of the California Administrative Code. Also see Figure II for Radiation Survey Record.

6. It is mandatory that a physical radiation survey be made immediately after each radiographic exposure is completed. This is to determine that all sources have been returned to their storage containers or retracted into the safe position into the camera projector.

Mr. Jonas, Mr. Kendrick, and/or Mr. Milliron or a licensed private laboratory will leak test the cesium and cobalt sources at 6 month intervals, and the leak tests will be sent to a licensed radiation laboratory for precise and independent evaluation.

Records of wipe test results will be kept on file for the California Department of Public Health and for safety inspection.

K. Instructions for Restricting Radiographic Areas.

1. The State radiography program does not currently provide a permanent established radiographic area. The majority of the radiographic inspection is done on structural steel bridges at jobsite locations.

2. The security measures observed at jobsite location must conform to the Federal Register Title 10 and Amendments Part 20, 20.201, 20.202, and 20.203, and the laws and regulations relating to atomic energy development and radiation protection from California Health and Safety Code, California Penal Code, and California Administrative Code.

3. All radiographic exposures must be personally under the radiographic technician's surveillance including roped off and signed areas. See Figure II and IIa for Radiation Survey Record.

L. Personal Monitoring

1. The radiographic technician, when handling radioactive materials or subjected to radiation, must wear a film badge which records the total dosage received. Separate badges are to be used for X and gamma radiation. Film badges are to be developed weekly.

2. The film badge service is handled under a contracted service agreement through a private laboratory. The film badge service is the twin-film type, which reveals a weekly and a 13-week cumulative exposure for personal monitoring of radiation received from X or gamma rays.

   The evaluation is made by the service laboratory and reports sent in triplicate each week, and at the end of 13-weeks the cumulative report is evaluated and the results are reported in triplicate.

3. The radiographic technician must also wear a dosimeter of the Victoreen Direct reading Model 541/A 200 mr full scale type.

4. Daily dosimeter readings shall be posted on the personal radiation exposure record (Form T-646). See Figure I, Page 10, for comparison with the weekly badge exposure report.

5. Each employee as listed herein shall be under the supervision of, or in consultation with, a competent medical expert experienced in the diagnosis of harmful effects of ionized radiation. Prior to starting ionizing radiation and again at intervals not less than once annually while so employed for radiographic inspection, a physical examination shall be performed by the M.D. Periodic blood tests no more than six months apart shall be included under the above policy. Reports of the medical examination and blood tests shall be kept current and on file with the employee's radiation exposure records.

M. Transporting of Sources to Field Locations

Radioactive sources shall be transported and stored in a State owned truck adapted especially for this purpose. The containers are secured by a bracket and locked with a separate lock other than the lock that is on the source container.

The source containers and brackets shall be locked at all times except when sources are being removed from the containers or the container is being used as a projector.

The keys to the containers, bracket locks, and projector locks are placed in the custody of the radiographic technician to whom the sources have been entrusted.

The source projectors and cobalt 60 container are so shielded that there shall not be any radiation in excess of 2 mr/hr at the surface of the radiographic truck.

The radiation level in the driving compartment shall be less than 2 mr/hr. This shall be physically surveyed continuously for assurance.

1. The Kel-Ray Projector Model C-B for the cesium 137, 20 curie source, will be shielded, bracketed, and locked within the radiographic truck for transporting and storage.

2. The Iridium Projector Curtiss-Wright Model 10-5A, accommodated with the 30 curie iridium source, will be shielded, bracketed, and locked within the radiographic truck for transporting and storage.

3. In addition to locked source containers, the radiographic truck has locked doors, and the technician shall keep these radiographic truck doors locked at all times except when sources are being removed or returned to their containers or brackets.

4. When the sources or containers are being removed from the radiographic truck, the truck shall be posted according to the Federal Register Title 10, Part 20, Section 20.203.

5. The radiographic truck, when not in use, shall be locked and preferably backed up to a concrete wall or barrier so a thief would not be tempted to break open the locked door.

   The keys to the radiographic truck shall be entrusted to no one but the radiographic technician to whom the keys have been issued.

6. In case of a road accident when transporting the sources (and resulting in radiation danger), the local Civil Authorities and the California Division of Highways, Materials and Research Department, shall be notified. Telephone number is Sacramento, GLadstone 2-5481. Ask for Mr. Paul Jonas. If Mr. Jonas cannot be reached, then ask for Mr. Victor Sayers. He will then notify the proper authorities to take action.

   Specific instructions to this effect will be printed on the dashboard of the radiographic truck on the driver's side. Also refer to Emergency Procedures (Q).

N. Shipment of Radioactive Sources

In case shipment by commercial carriers becomes necessary, prior authority will be secured from headquarters and the

appropriate Interstate Commerce Commission regulations will be complied with.

O. Security of Sources When Stored in Areas Other Than The Radiographic Truck.

1. When the radiographic truck is at the headquarters office, the sources shall be stored in the subterranean concrete vault. This vault is equipped with steel doors and locked. The keys to this vault are in Mr. Paul Jonas' possession.

2. The standard warning signs are posted on the steel doors of the concrete vault.

3. There is no radiation level from the sources at the external surfaces of the concrete vault or the steel doors.

4. When sources are being removed from or returned to the storage vault, a physical survey shall be made in each case.

P. Removal and Exchange of Sealed Sources

1. For the Model 10-5A Curtiss-Wright Iridium 192 camera, the annual contract calls for an original and five replacements of one 30 curie iridium 192 source, especially encapsulated as per U.S. Nuclear drawing B-0074. Shipments are based on the half life of the iridium 192.

2. The removal and exchange of the iridium 192 capsule from the special shipping container to the 10-5A camera will be as follows:

   The U. S. Nuclear special shipping container for the iridium source is equipped with two compartments especially fitted to take the iridium camera source cable. The half-spent iridium source is then blown into the shipping container.

   The source cable is then fitted to the new iridium source compartment and the new source blown back into the iridium camera.

   The U. S. Nuclear iridium source 192 shipping container is then locked and shipped back to the U. S. Nuclear Company via air express, according to appropriate shipping regulations.

Note: A physical radiation survey is always maintained to assure the radiographic technician that the sources are in their proper places.

Q. Emergency Procedures

For emergency such as listed below, immediately call the local Civil authorities and California Division of Highways, Materials and Research Department, Sacramento, California, phone GLadstone 2-5481 and ask for Mr. Paul G. Jonas. If unable to contact Mr. Jonas, ask for Mr. Victor Sayers.

1. In the event of an accident involving the radiographic truck and sources, the technician shall rope off the area until the Civil authorities and/or the Disaster Squad arrive.

2. In case of theft or loss of radioactive materials, the technician shall immediately notify the above.

EXPOSURE RECORD

The radiation exposure record, Figure I, shall be filled out completely in triplicate by the radiographic technician for the type of radiation he receives. The dosage reported shall be that as recorded by the pocket dosimeter.

The radiation exposure record shall be turned in once a month with the technician's time sheets or as requested by the department or safety section.

MATERIALS & RESEARCH DEPARTMENT

RADIATION EXPOSURE RECORD
(Recorded by Pocket Dosimeter)
FORM T-646 (REV. 9-59)

SIGNATURE: ____________________

MONTH: ____________________ 19____

Show Date Below Each Day

Total Radiation to date:		Mr	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
SOURCE	X-Ray	Mr							
	Iridium 192	Mr							
	Cesium 137	Mr							
	Cobalt 60	Mr							
Radiation Received This Week		Mr							
Total Radiation to date:		Mr	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
SOURCE	X-Ray	Mr							
	Iridium 192	Mr							
	Cesium 137	Mr							
	Cobalt 60	Mr							
Radiation Received This Week		Mr							
Total Radiation to date:		Mr	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
SOURCE	X-Ray	Mr							
	Iridium 192	Mr							
	Cesium 137	Mr							
	Cobalt 60	Mr							
Radiation Received This Week		Mr							
Total Radiation to date:		Mr	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
SOURCE	X-Ray	Mr							
	Iridium 192	Mr							
	Cesium 137	Mr							
	Cobalt 60	Mr							
Radiation Received This Week		Mr							
Total Radiation to date		Mr	Sun.	Mon	Tue.	Wed.	Thu.	Fri.	Sat.
SOURCE	X-Ray	Mr							
	Iridium 192	Mr							
	Cesium 137	Mr							
	Cobalt 60	Mr							
Radiation Received This Week		Mr							

Figure I

The radiation survey record, Figure II or IIa, whichever is appropriate to the job, shall be made out in triplicate for each radiographic exposure. The sign stations and sign location should show the mr/hr and the distance in feet from the source used or set-up location.

The radiation survey records should be turned in as follows: one should stay with the radiograph exposed, one should go into the contract file, and one should stay in the technician's file until the job is completed.

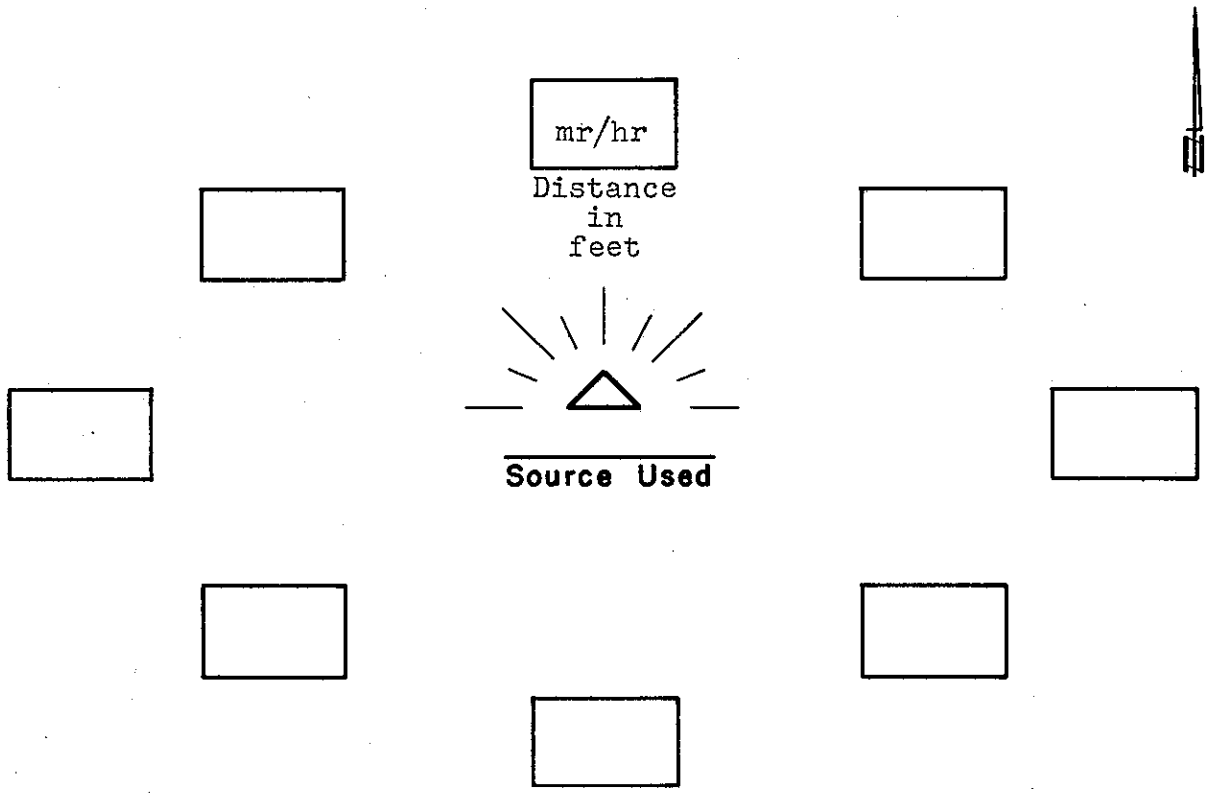
RADIATION SURVEY RECORD

Contract No._____ Co._____ Rt._____ Sec._____

Technician_____ Structure_____

Date_____ Structural Shape_____

PLAN VIEW OF SET-UP & SIGN LOCATION



Exposure No.	Exposure Time	Structural Unit	Remarks

Figure II

RADIATION SURVEY RECORD

Contract No._____ Co._____ Rt._____ Sec._____

Technician _____ Structure _____

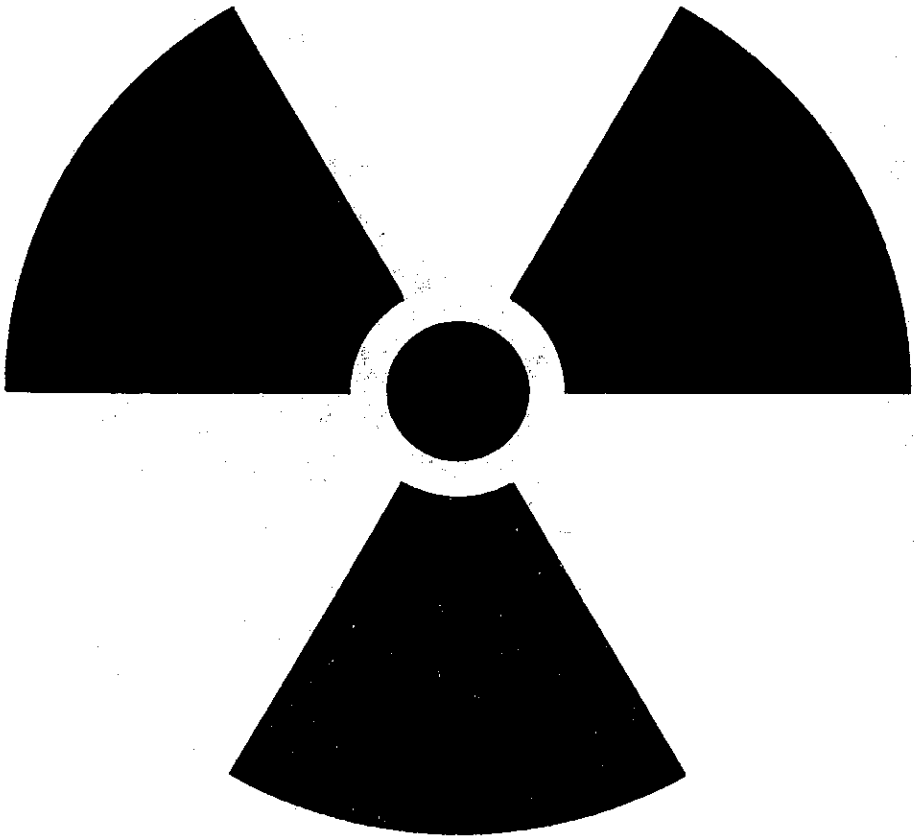
Date_____ Structural Shape _____

Set-up	Set-up Location	Sign Sta. No.	Sign Location	mr / hr
			IN FEET	

Figure IIa

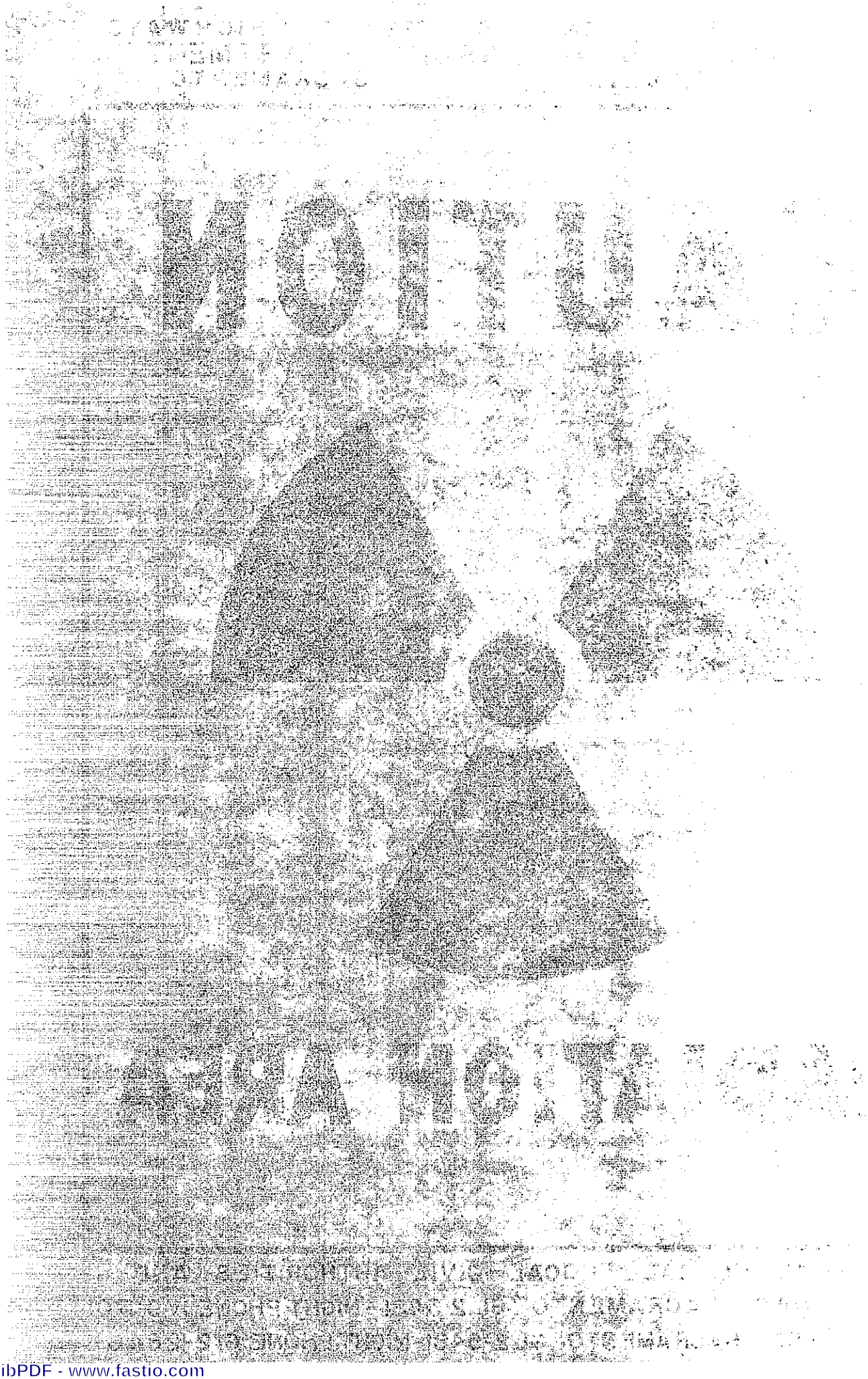
STATE OF CALIFORNIA DIVISION OF HIGHWAYS
MATERIALS & RESEARCH DEPARTMENT
5900 FOLSOM BLVD. SACRAMENTO

CAUTION



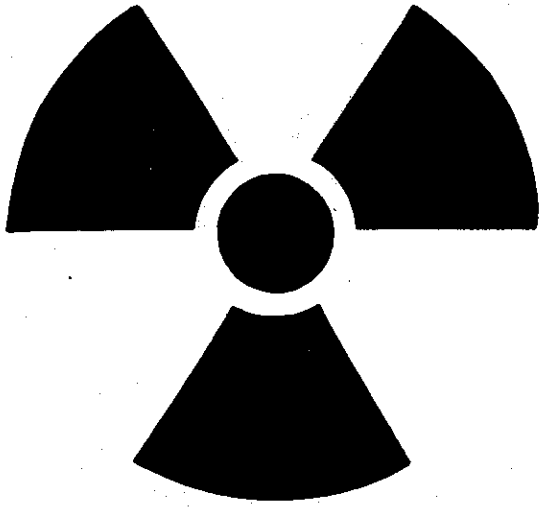
RADIATION AREA

IN EMERGENCY CALL LOCAL CIVIL AUTHORITIES AND
PAUL JONAS SACRAMENTO GL 2-5481 - NIGHT PHONE IV 9-1701
VIC SAYERS SACRAMENTO GL 2-5481 - NIGHT PHONE GI 2-2846



STATE OF CALIFORNIA DIVISION OF HIGHWAYS
MATERIALS & RESEARCH DEPARTMENT
5900 FOLSOM BLVD. SACRAMENTO

CAUTION



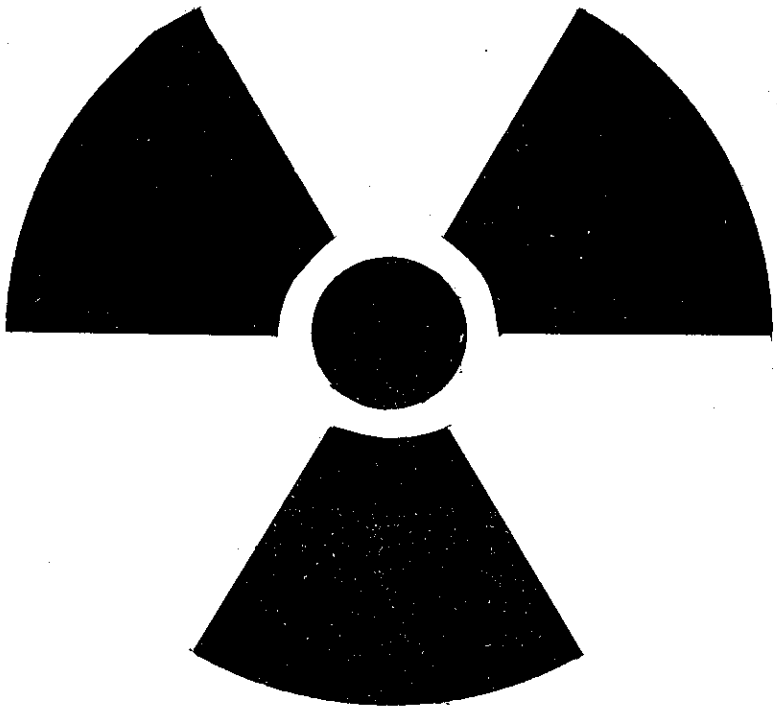
RADIATION AREA

DO NOT ENTER THIS AREA

IN EMERGENCY CALL LOCAL CIVIL AUTHORITIES AND
PAUL JONAS SACRAMENTO GL 2-5481 - NIGHT PHONE IV 9-1701
VIC SAYERS SACRAMENTO GL2-5481-NIGHT PHONE GI 2-2846

STATE OF CALIFORNIA DIVISION OF HIGHWAYS
MATERIALS & RESEARCH DEPARTMENT
5900 FOLSOM BLVD. SACRAMENTO

CAUTION



HIGH RADIATION AREA

IN EMERGENCY CALL LOCAL CIVIL AUTHORITIES AND
PAUL JONAS SACRAMENTO GL 2-5481 - NIGHT PHONE IV 9-1701
VIC SAYERS SACRAMENTO GL2-5481-NIGHT PHONE GI 2-2846

MATERIALS & RESEARCH DEPARTMENT

RADIATION SURVEYS & SURVEY RECORDS

DATE	LOCATION	MODEL NO. SOURCE	TIME		Hrs. in USE	AREA SURVEYED	CONTRACT
			START	FINISH			

Form T-675 (Orig. 1-61)

MATERIALS & RESEARCH DEPARTMENT

UTILIZATION LOG

DATE		MODEL NO.	TECHNICIAN	LOCATION	CONTRACT
OUT	RETURN	SOURCE			

Form T-674 (Orig. 1-61)

MATERIALS & RESEARCH DEPARTMENT

QUARTERLY INVENTORY RECORD OF SOURCES

DATE		SOURCE #	CURIE	REMARKS
IVED	RETURNED			

Form T-676 (Orig. 1-61)

Form Approved.
Bureau of Budget No. 88-R119.
Expiration Date: June 30, 1961

T-2069 (ORIG. 12-60)

U.S. ATOMIC ENERGY COMMISSION

OCCUPATIONAL EXTERNAL RADIATION EXPOSURE HISTORY

See Instructions on the Back

IDENTIFICATION

1. NAME (PRINT—LAST, FIRST, AND MIDDLE)	2. SOCIAL SECURITY NO.
DATE OF BIRTH (MONTH, DAY, YEAR)	4. AGE IN FULL YEARS (N)

OCCUPATIONAL EXPOSURE—PREVIOUS HISTORY

PREVIOUS EMPLOYMENTS INVOLVING RADIATION EXPOSURE—LIST NAME AND ADDRESS OF EMPLOYER	6. DATES OF EMPLOYMENT (FROM—TO)	7. PERIODS OF EXPOSURE	PREVIOUS DOSE HISTORY 8. WHOLE BODY (REM)	9. INSERT ONE: RECORD OR CALCULATED
		11. ACCUMULATED OCCUPATIONAL DOSE—TOTAL		

10. REMARKS

12. CERTIFICATION: I CERTIFY THAT THE EXPOSURE HISTORY LISTED IN COLUMNS 5, 6, AND 7 IS CORREC AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND BELIEF.

EMPLOYEE'S SIGNATURE

DATE

13. CALCULATIONS—PERMISSIBLE DOSE

WHOLE BODY:

(A) PERMISSIBLE ACCUMULATED DOSE = 5(N-18) = _____ REM

(B) TOTAL EXPOSURE TO DATE (FROM ITEM 11) = _____ REM

(C) PERMISSIBLE DOSE = _____ REM

14. NAME OF LICENSEE

INSTRUCTIONS FOR PREPARATION OF FORM AEC-4

This form or a clear and legible record containing all the information required on this form must be completed by each licensee of the Atomic Energy Commission who, pursuant to Section 20.101, proposes to expose an individual to a radiation dose in excess of the amounts specified in Section 20.101(a) of the regulations in Part 20, "Standards for Protection Against Radiation," 10 CFR. The requirement for completion of this form is contained in Section 20.102 of that regulation. The information contained in this form is used for estimating the accumulated occupational dose of the individual for whom the form is completed. A separate form shall be completed for each individual to be exposed to a radiation dose in excess of the limits specified in Section 20.101(a) of the Part 20 regulations.

Listed below by item are instructions and additional information directly pertinent to completing this form:

Identification

Item 1. Self-explanatory.

Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.

Item 3. Self-explanatory.

Item 4. Enter the age in full years. This is called "N" when used in calculating the Permissible Dose. N is equal to the number of years of age of the individual on his last birthday.

Occupational Exposure

Item 5. List the name and address of each previous employer and the address of employment. Start with the most recent employer and work back.

Include only those periods of employment since the eighteenth birthday involving occupational exposure to radiation. For periods of self-employment, insert the word "self-employed."

Item 6. Give the dates of employment.

Item 7. List periods during which occupational exposure to radiation occurred.

Item 8. List the dose recorded for each period of exposure from records of previous occupational exposure of the individual as calculated under Section [illegible] Dose is to be given in rem.

"Dose to the whole body" shall be deemed [illegible] clude any dose to the whole body, gonads, [illegible] blood-forming organs, head and trunk, or [illegible] eye.

Calculated Dose

Item 9. After each entry in Item 8 indicate in [illegible] whether dose is obtained from records or [illegible] lated in accordance with Section 20.102.

Item 10. Self-explanatory.

Total Accumulated Occupational Dose (Whole Body)

Item 11. The total for the whole body is obtained by [illegible] mation of all values in Item 8.

Certification

Item 12. Upon completion of the report, the employer [illegible] certify that the information in Columns 5, 6, and [illegible] is accurate and complete to the best of his knowledge. The date is the date of his signature.

Calculations

Item 13. The lifetime accumulated occupational dose for each individual and the permissible dose under Section 20.101(b) are obtained by carrying out the following steps: The value for N should be taken from Item 4. Subtract 18 from N and multiply the difference by 5 rem. (For example, John Smith, age 32; N=32, MPD=5(32–18)=70 rem.) Enter total exposure to date from Item 11. Subtract (b) from (a) and enter the difference under (c). The value in (c) represents the dose to the whole body to which that individual can be exposed in accordance with Section 20.101(b). This value for permissible dose is to be carried forward to Form AEC-5, "Current Occupational External Radiation Exposure (Whole Body)."

Item 14. Self-explanatory.

Form approved.
Bureau of Budget No. 38-R120.
Expiration date: June 30, 1961.

AEC-5
(9-60)
T-2070 (ORIG. 12-60)

U.S. ATOMIC ENERGY COMMISSION

CURRENT OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

See Instructions on the Back

IDENTIFICATION

1. NAME (PRINT—Last, first, and middle)	2. SOCIAL SECURITY NO.
3. DATE OF BIRTH (Month, day, year)	4. AGE IN FULL YEARS (N)

OCCUPATIONAL EXPOSURE

5. DOSE RECORDED FOR (Specify: Whole body; skin of whole body; or hands and forearms, feet and ankles.)	6. PERMISSIBLE DOSE AT BEGINNING OF PERIOD COVERED BY THIS SHEET	7. METHOD OF MONITORING (e.g., Film Badge—FB; Pocket Chamber—PC; Calculations—Calc.) GAMMA _____ BETA _____ NEUTRONS _____

8. PERIOD OF EXPOSURE (From—to)	DOSE FOR THE PERIOD (rem)				13. RUNNING TOTAL FOR CALENDAR QUARTER (rem)
	9. GAMMA	10. BETA	11. NEUTRON	12. TOTAL	

LIFETIME ACCUMULATED DOSE

14. PREVIOUS TOTAL rem	15. TOTAL DOSE RECORDED ON THIS SHEET rem	16. TOTAL ACCUMULATED DOSE rem	17. PERM. ACC. DOSE 5(N—18)= rem	18. PERMISSIBLE DOSE rem

19. NAME OF LICENSEE

INSTRUCTIONS FOR PREPARATION OF FORM AEC-5

The preparation and safekeeping of this form or a clear and legible record containing all the information required on this form, is required pursuant to Section 20.401 of "Standards for Protection Against Radiation," 10 CFR 20, as a current record of occupational external radiation exposures. Such a record must be maintained for each individual for whom personnel monitoring is required under Section 20.202. Note that a separate copy of this form is to be used for recording external exposure to whole body; and skin of whole body; or hands and forearms, feet and ankles as provided by Item 5 below.

Listed below by item are instructions and additional information directly pertinent to completing this form.

Identification

Item 1. Self-explanatory.

Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.

Item 3. Self-explanatory.

Item 4. Enter the age in full years. This is called "N" when used in calculating the Maximum Permissible Dose. N is equal to the number of years of age of the individual on his last birthday.

Occupational Exposure

Item 5. Use separate form to record exposure to whole body; skin of whole body; hands and forearms, feet and ankles—Specify in Item 5.

If an individual receives a radiation dose to the skin of the whole body from radiation of half-value layer less than 5 cm. of tissue, the dose to the skin of the whole body should be recorded on a separate form, unless the dose to the skin of the whole body as indicated by personnel monitoring devices has been included as dose to the whole body on a form maintained for recording whole body exposures.

If an individual receives a radiation dose to the hands and forearms, or feet and ankles, the dose to those portions of the body should be recorded on separate forms unless the dose to those parts of the body as indicated by personnel monitoring devices have been included as doses to the whole body on a form maintained for recording whole body exposure.

"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.

Item 6. The permissible dose is taken from (a) previous records of exposure recorded by the licensee (i.e., Item 18 of a previous Form AEC-5; or Item 13 of Form AEC-4 if the individual's exposure during employment with the licensee begins with this record); or (b) Section 20.101(a) which limits the whole body dose to 1¼ rem per quarter if the licensee chooses not to refer to previous exposure.

Item 7. Indicate the method used for monitoring the individual's exposure to each type of radiation to which he is exposed in the course of his duties. Abbreviations may be used.

Item 8. The period of exposure should specify the day the monitoring of that exposure was initiated and the day on which it was terminated. For example, a film badge issued Monday morning, August 4, 1958, and picked up Friday, August 15, 1958, would be indicated 8/4/58–8/15/58.

Items 9, 10 and 11. Self-explanatory. The values are to be given in rem. measurements are to be interpreted in the best method known and in accordance with Section 20.4(c). A description of method of analyzing the monitoring results in terms of [illegible] is to be maintained in conjunction with these records. In any case where the dose for a calendar quarter is less than 10% of the value specified in Paragraph (a) Section 20.101 the phrase "less than 10%" may be entered in lieu of a numerical value.

Item 12. Add the values under Items 9, 10 and 11 for each period of exposure and record the total. In calculating the "Total" any entry "less than 10%" may be disregarded.

Item 13. The running total is to be maintained on the basis of calendar quarters. Section 20.3(a)(4) defines calendar quarter.

Lifetime Accumulated Dose (Whole Body)

NOTE: If the licensee chooses to keep the individual's exposure below that permitted in Section 20.101(a), Items 14 through 18 need not be completed. However, in that case the total whole body dose for each calendar quarter recorded in Item 13 should not exceed 1¼ rem as indicated in Item 6.

Complete Items 14 through 18 when body of record in full. Values in Column 13, when in the middle of the calendar quarter, and Item 18 must be brought forward to next sheet for each individual.

Item 14. Enter the previous total accumulated dose from previous dose records for the individual (e.g., Item 16 if Form AEC-5 or Item 11 if Form AEC-4).

Item 15. Enter the sum of all totals under Item 12.

Item 16. Add Item 14 and Item 15 and enter that sum.

Item 17. Obtain the Permissible Accumulated Dose (MPD) in rem for the WHOLE BODY. Use the value for N from Item 4. Subtract 18 from N and multiply the difference by 5 rem (e.g., John Smith, age 32; N=32, MPD=5(32−18)=70 rem).

Item 18. Determine the Permissible Dose by subtracting Item 16 from Item 17. The Permissible Dose is that portion of the Lifetime Accumulated Dose for the individual remaining at the end of the period covered by this sheet.

Item 19. Self-explanatory.

Rules and Regulations

Title 10—ATOMIC ENERGY

Chapter I—Atomic Energy Commission

PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

Statement of considerations. The Atomic Energy Commission's regulation 10 CFR Part 20 is hereby republished for the purpose of incorporating into one document all amendments to the regulation to date, including the amendment published in the FEDERAL REGISTER on September 7, 1960, to become effective January 1, 1961.

AUTHORITY: §§ 20.1 to 20.601 issued under sec. 161, 68 Stat. 948, as amended; 42 U. S. C. 2201.

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 Atomic Energy Commission and are issued pursuant to the Atomic Energy Act of 1954 (68 Stat. 919).

(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 exposure to such material and to radiation from such material, when added to exposures to unlicensed radioactive material and to other unlicensed sources of radiation in the possession of the licensee, and to radiation therefrom, does not exceed the standards of radiation protection prescribed in the regulations in this part.

§ 20.2 Scope.

The regulations in this part apply to all persons who receive, possess, use or transfer byproduct material, source material, or special nuclear material under a general or specific license issued by the Commission pursuant to the regulations in Part 30, 40, or 70 of this chapter.

§ 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 any period determined according to either of the following subdivisions:

(i) January 1 to March 31, inclusive; April 1 to June 30, inclusive; July 1 to September 30, inclusive; October 1 to December 31, inclusive; or

(ii) The first period in a calendar year of 13 complete, consecutive calendar weeks; the second period in a calendar year of 13 complete, consecutive calendar weeks; the third period in a calendar year of 13 complete, consecutive calendar weeks; the fourth period in a calendar year of 13 complete, consecutive calendar weeks. If at the end of a calendar year there are any days not falling within a complete calendar week of that year, such days shall be included (for purposes of this part) within the last complete calendar week of that year. If at the beginning of any calendar year there are days not falling within a complete calendar week of that year, such days shall be included (for purposes of this part) within the last complete calendar week of the previous year.

No licensee shall change the method observed by him of determining calendar quarters for purposes of this part except at the beginning of a calendar year.

(5) "Commission" means the Atomic Energy 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 byproduct 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 Part 30, 40, or 70 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, any State, any foreign government or nation or any political subdivision of any such government or nations, 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. "Restricted area" shall not in-

576148—O—60

clude 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 any material except special nuclear material, which contains by weight one-twentieth of one percent (0.05 percent or more of (i) uranium, (ii) thorium, or (iii) any combination thereof);

(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 entry into which is not controlled by the licensee, and any area used for residential quarters.

(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 tissue 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;

(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 subparagraph (3) of this paragraph, 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/cm²)	Average flux to deliver 100 millirem in 40 hours (neutrons/cm² per sec.)
Thermal	970×10^6	670
0.0001	720×10^6	500
0.005	820×10^6	570
0.02	400×10^6	280
0.1	120×10^6	80
0.5	43×10^6	30
1.0	26×10^6	18
2.5	29×10^6	20
5.0	26×10^6	18
7.5	24×10^6	17
10	24×10^6	17
10 to 30	14×10^6	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 (c) $=3.7\times10^{10}$ disintegrations per second (dps) $=2.2\times10^{12}$ disintegrations per minute (dpm). A commonly used submultiple of the curie is the microcurie (μc). One μc=0.000001 c$=3.7\times10^4$ dps$=2.2\times10^6$ dpm.

(b) For purposes of the regulations in this part, it may be assumed that the daughter activity concentrations in the following table are equivalent to an air concentration of 10^{-7} microcuries of Radon 222 per milliliter of air in equilibrium with the daughters RaA, RaB, RaC, and RaC′:

Maximum time between collection and measurement (hours)[1]	Alpha-emitting daughter activity collected per milliliter of air	
	Microcuries/cc	Total alpha disintegrations per minute per cc.
0.5	7.2×10^{-5}	0.16
1	4.5×10^{-5}	0.10
2	1.3×10^{-5}	0.028
3	0.3×10^{-5}	0.0072

[1] The duration of sample collection and the duration of measurement should be sufficiently short compared to the time between collection and measurement, as not to have a statistically significant effect upon the results.

(c) *Natural uranium and natural thorium.* (1) For purposes of the regulations in this part, one curie of natural uranium (U–natural in Appendix B or C) means the sum of 3.7×10^{10} disintegrations per second from U–238 plus 3.7×10^{10} dis/sec from U–234 plus 9×10^8 dis/sec from U–235. Also, a curie of natural thorium (thorium-natural in Appendix B or C) means the sum of 3.7×10^{10} dis/sec from Th^{232} plus 3.7×10^{10} dis/sec from Th^{228}.

(2) For the purpose of the regulations in this part, one curie of natural uranium (U–natural in Appendix B or C) is equivalent to 3,000 kilograms, or 6,615 pounds of natural uranium; and one curie of natural thorium (thorium-natural in Appendix B or C) is equivalent to 9,000 kilograms or 19,850 pounds of natural thorium.

§ 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.

All communications and reports concerning the regulations in this part, and applications filed under them, should be addressed to the Atomic Energy Commission, Washington 25, D.C., Attention: Division of Licensing and Regulation. Communications and reports may be delivered in person at the Commission's offices at 1717 H Street NW., Washington, D.C., or its offices at Germantown, Md.

§ 20.101 Exposure of individuals to radiation in restricted areas.

(a) 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 in the licensee's possession a dose in excess of the limits specified in the following table:

Rems per calendar quarter

1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	1¼
2. Hands and forearms; feet and ankles	18¾
3. Skin of whole body	7½

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

(1) During any calendar quarter the dose to the whole body from radioactive material and other sources of radiation in the licensee's possession 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 AEC–4,

clear and legible record contain- the information required in that and has otherwise complied with ...ements of § 20.102. As used in ... (b), "Dose to the whole body" deemed to include any dose to ... body, gonads, active blood-organs, head and trunk, or lens

Determination of accumulated

... section contains require- ... must be satisfied by who propose, pursuant to para- of § 20.101, to permit individ- restricted area to receive ex- radiation in excess of the limits paragraph (a) of § 20.101.

... permitting any individual ...ted area to receive exposure in excess of the limits spec- ...graph (a) of § 20.101, each

... a certificate on Form on a clear and legible record all the information required ... signed by the individual ... period of time after the ...ned the age of 18 in which ... received an occupational ..., and

... on Form AEC-4 in ac- the instructions appear- or on a clear and legible ... all the information ... form, the previously ac- ...ational dose received by and the additional dose that individual under

... preparation of Form ... and legible record con- information required in licensee shall make a rea- to obtain reports of the ...viously accumulated oc- For each period for ... obtains such reports, ... use the dose shown in ...ing the form. In a licensee is unable to the individual's occu- a previous complete it shall be assumed ... has received the oc- specified in whichever columns apply:

Column 1	Column 2
Assumed exposure in rems for calendar quarters prior to Jan. 1, 1961	Assumed exposure in rems for calendar quarters beginning on or after Jan. 1, 1961
3¾	1¼

shall retain and pre- in preparing Form

the individual's ac- ... dose for all ...ary 1, 1961 yields the applicable ac- for the individual ...ified in paragraph ...ess may be disre-

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

(a) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual in a restricted area 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 I, of this part. "Expose" as used in this section means that the individual is present in an airborne concentration. No allowance shall be made for the use of protective clothing or equipment, or particle size, except as authorized by the Commission pursuant to paragraph (c) of this section.

(b) The limits given in Appendix B, Table I, of this part are based upon exposure to the concentrations specified for forty hours in any period of seven consecutive days. In any such period where the number of hours of exposure is less than forty, the limits specified in the table may be increased proportionately. In any such period where the number of hours of exposure is greater than forty, the limits specified in the table shall be decreased proportionately.

(c) (1) Except as authorized by the Commission pursuant to this paragraph, no allowance shall be made for particle size or the use of protective clothing or equipment in determining whether an individual is exposed to an airborne concentration in excess of the limits specified in Appendix B, Table I.

(2) The Commission may authorize a licensee to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix B, Table I, upon receipt of an application demonstrating that the concentration is composed in whole or in part of particles of such size that such particles are not respirable; and that the individual will not inhale the concentrations in excess of the limits established in Appendix B, Table I. Each application under this subparagraph shall include an analysis of particle sizes in the concentrations; and a description of the methods used in determining the particle sizes.

(3) The Commission may authorize a licensee to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix B, Table I, upon receipt of an application demonstrating that the individual will wear appropriate protective equipment and that the individual will not inhale, ingest or absorb quantities of radioactive material in excess of those which might otherwise be permitted under this part for employees in restricted areas during a 40-hour week. Each application under this subparagraph shall contain the following information:

(i) A description of the protective equipment to be employed, including the efficiency of the equipment for the material involved;

(ii) Procedures for the fitting, maintenance and cleaning of the protective equipment; and

(iii) Procedures governing the use of the protective equipment, including supervisory procedures and length of time the equipment will be used by the individuals in each work week. The proposed periods for use of the equipment by any individual should not be of such duration as would discourage observance by the individual of the proposed procedures; and

(iv) The average concentrations present in the areas occupied by employees.

§ 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 paragraph (c) of § 20.103, shall apply to exposures subject to paragraph (b) of this section.

§ 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.

§ 20.106 Concentrations in effluents to unrestricted areas.

(a) There may be included in any application for a license or for amendment of a license proposed limits upon concentrations of licensed and other radioactive material released into air or water in unrestricted areas as a result

of the applicant's proposed activities. Such applications should include information as to anticipated average concentrations and anticipated occupancy times for each unrestricted area involved. The Commission will approve the proposed limits if the applicant demonstrates that it is not likely that any individual will be exposed to concentrations 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 one year.

(b) Except as authorized by the Commission pursuant to § 20.302 or paragraph (a) of this section, no licensee shall possess, use or transfer licensed material in such a manner as to release into air or water in any unrestricted area any concentration of radioactive material 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 one year.

(c) For purposes of this section, determinations as to the concentration of radioactive material shall be made with respect to the point where such material leaves the restricted area. Where the radioactive material is discharged through a stack, tube, pipe, or similar conduit, the determination may be made with respect to the point where the material leaves such conduit.

(d) The provisions of this section do not apply to disposal of radioactive material into sanitary sewerage systems (see § 20.303).

§ 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 may be necessary for him to comply with the regulations in this part.

§ 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;

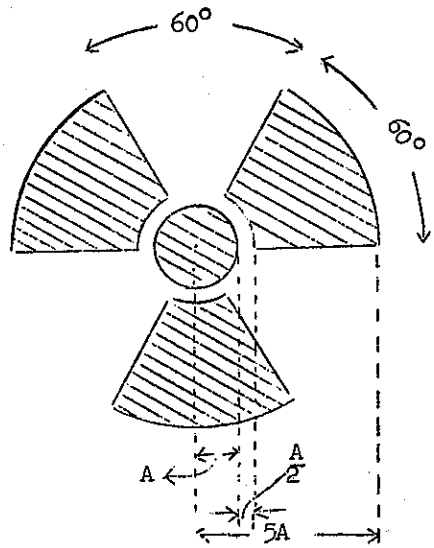
(3) "High radiation area" means any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

§ 20.203 Caution signs, labels, and signals.

(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:

CAUTION [1]
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:

CAUTION [1]
HIGH RADIATION AREA

(2) Each high radiation area shall be equipped with a control device which shall either cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirem in one hour upon entry into the area or shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering and the licensee or a supervisor of the activity are made aware of the entry. In the case of a high radiation area established for a period of 30 days or less, such control device is not required.

(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 [1]
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:

CAUTION [1]
RADIOACTIVE MATERIAL(S)

(2) Each area or room in which natural uranium or thorium is used or stored in an amount exceeding one-hundred times the quantity specified in Appendix C of this part shall be conspicuously posted with a sign or signs

[1] Or "Danger".

bearing the radiation caution symbol and the words:

CAUTION [1]
RADIOACTIVE MATERIAL(S)

(f) *Containers.* (1) Each container in which is transported, stored, or used a quantity of any licensed material (other than natural uranium or thorium) greater than the quantity of such material specified in Appendix C of this part shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

CAUTION [1]
RADIOACTIVE MATERIAL

(2) Each container in which natural uranium or thorium is transported, stored, or used in a quantity greater than ten times the quantity specified in Appendix C of this part shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

CAUTION [1]
RADIOACTIVE MATERIAL

(3) Notwithstanding the provisions of subparagraphs (1) and (2) a label shall not be required:

(i) If the concentration of the material in the container does not exceed that specified in Appendix B, Table I, Column 2 of this part, or

(ii) For laboratory containers, such as beakers, flasks, and test tubes, used transiently in laboratory procedures, when the user is present.

(4) Where containers are used for storage, the labels required in this paragraph shall state also the quantities and kinds of radioactive materials in the containers and the date of measurement of the quantities.

§ 20.204 Exceptions from posting requirements.

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 because of the presence of patients containing byproduct material provided that there are personnel in attendance who shall 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.

§ 20.205 Exemptions for radioactive materials packaged for shipment.

Radioactive materials packaged and labeled in accordance with regulations of the Interstate Commerce Commission shall be exempt from the labeling and posting requirements of § 20.203 during shipment, provided that the inside containers are labeled in accordance with the provisions of § 20.203(f).

§ 20.206 Instruction of personnel; posting of notices to employees.

(a) All individuals working in or frequenting any portion of a restricted area shall be informed of the occurrence of radioactive materials or of radiation in such portions of the restricted area; shall be instructed in the safety problems associated with exposure to such materials or radiation and in precautions or procedures to minimize exposure; shall be instructed in the applicable provisions of Commission regulations and licenses for the protection of personnel from exposures to radiation or radioactive materials; and shall be advised of reports of radiation exposure which employees may request pursuant to these regulations.

(b) Each licensee shall post a current copy of the regulations in this part, a copy of the license, and a copy of operating procedures applicable to work under the license conspicuously in a sufficient number of places in every establishment where employees are employed in activities licensed by the Commission to permit them to observe such documents on the way to or from their place of employment or shall keep such documents available for employees' examination upon request.

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

NOTE: Copies of Form AEC-3 "Notice to Employees", may be obtained by writing to the Manager, appropriate AEC Operations Office or the Director, Division of Licensing and Regulation, Washington 25, D.C.

§ 20.207 Storage of licensed materials.

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

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 Part 30, 40, or 70 of this chapter, whichever may be applicable; or

(b) As authorized pursuant to § 20.302; or

(c) As provided in § 20.303 or § 20.304, applicable respectively to the disposal of licensed material by release into sanitary sewerage systems or burial in soil, or in § 20.106 (Concentrations in Effluents to Unrestricted Areas).

§ 20.302 Method for obtaining approval of proposed disposal procedures.

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.

§ 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 subparagraphs (1) or (2) of this paragraph:

(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 I, 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 I, Column 2 of this part; and

(d) The gross quantity of licensed and other radioactive material released into the sewerage system by the licensee does not exceed one curie per year.

Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

§ 20.304 Disposal by burial in soil.

No licensee shall dispose of licensed material by burial in soil unless:

(a) The total quantity of licensed and other radioactive materials buried at any one location and time does not exceed, at the time of burial, 1,000 times the amount specified in Appendix C of this part; and

(b) Burial is at a minimum depth of four feet; and

(c) Successive burials are separated by distances of at least six feet and not more than 12 burials are made in any year.

§ 20.305 Treatment or disposal by incineration.

No licensee shall treat or dispose of licensed material by incineration except as specifically approved by the Commission, pursuant to §§ 20.106(a) and 20.302.

[1] Or "Danger."

RECORDS, REPORTS, AND NOTIFICATION

§ 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 AEC-5, in accordance with the instructions contained in that form or on clear and legible records containing all the information required by Form AEC-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 the appendices to this part, showing the results of surveys required by § 20.201 (b), and disposals made under §§ 20.302, 20.303, and 20.304.

(c) Records of individual radiation exposure which must be maintained pursuant to the provisions of this subsection shall be preserved until December 31, 1965 or until a date five years after termination of the individual's employment, whichever is later. Records which must be maintained pursuant to this part may be maintained in the form of microfilms.

NOTE: Prior to December 31, 1965 the Commission may amend this paragraph to assure the further preservation of records which it determines should not be destroyed.

§ 20.402 Reports of theft or loss of licensed material.

Each licensee shall report by telephone and telegraph to the Manager of the nearest Atomic Energy Commission Operations Office listed in Appendix D, immediately after its occurrence becomes known to the licensee, any loss or theft of licensed material in such quantities and under such circumstances that it appears to the licensee that a substantial hazard may result to persons in unrestricted areas.

§ 20.403 Notifications of incidents.

(a) *Immediate notification.* Each licensee shall immediately notify the Manager of the appropriate Atomic Energy Commission Operations Office shown in Appendix D by telephone and telegraph of any incident involving byproduct, source or special nuclear material possessed by him and which 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; 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 $100,000.

(b) *Twenty-four hour notification.* Each licensee shall within 24 hours notify the Manager of the appropriate Atomic Energy Commission Operations Office listed in Appendix D by telephone and telegraph of any incident involving licensed material possessed by him and which 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; or

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

(4) Damage to property in excess of $1,000.

§ 20.404 Report to former employees of exposure to radiation.

At the request of a former employee each licensee shall furnish to the former employee a report of the former employee's exposure to radiation as shown in records maintained by the licensee pursuant to § 20.401(a). Such report shall be furnished within 30 days from the time the request is made; shall cover each calendar quarter of the individual's employment involving exposure to radiation, or such lesser period as may be requested by the employee. The report shall also include the results of any calculations and analyses of radioactive material deposited in the body of the employee and made pursuant to the provisions of § 20.108. The report shall be in writing and contain the following statement:

This report is furnished to you under the provisions of the Atomic Energy Commission regulations entitled "Standards for Protection Against Radiation" (10 CFR Part 20). You should preserve this report for future reference.

(b) The former employee's request should include appropriate identifying data, such as social security number and dates and locations of employment.

§ 20.405 Reports of overexposures and excessive levels and concentrations.

(a) In addition to any notification required by § 20.403, each licensee shall make a report in writing within 30 days to the Director, Division of Licensing and Regulation, U.S. Atomic Energy Commission, Washington 25, D.C., of (1) each exposure of an individual to radiation or concentrations of radioactive material in excess of any applicable limit in this part or in the licensee's license; (2) any incident for which notification is required by § 20.403; and (3) levels of radiation or concentrations of radioactive material (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 licensee's license. Each report required under this paragraph shall describe the extent of exposure of persons to radiation or to radioactive material; levels of radiation and concentrations of radioactive material involved; the cause of the exposure, levels or concentrations; and corrective steps taken or planned to assure against a recurrence. The licensee shall transmit a copy of each report to the Manager of the appropriate Atomic Energy Commission Operations Office listed in Appendix D.

(b) In any case where a licensee is required pursuant to the provisions of this section to report to the Commission any exposure of an individual to radiation or to concentrations of radioactive material, the licensee shall also notify such individual of the nature and extent of exposure. Such notice shall be in writing and shall contain the following statement:

This report is furnished to you under the provisions of the Atomic Energy Commission regulations entitled "Standards for Protection Against Radiation" (10 CFR Part 20). You should preserve this report for future reference.

§ 20.406 Notice to employees of exposure to radiation.

At the request of any employee, each licensee shall advise such employee annually of the employee's exposure to radiation as shown in records maintained by the licensee pursuant to § 20.401(a).

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 act or any regulation or order issued thereunder. 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.

APPENDIX A [Reserved]

APPENDIX B

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

[See notes at end of appendix]

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Actinium (89)	Ac 227	S	2×10^{-12}	6×10^{-5}	8×10^{-14}	2×10^{-6}
		I	3×10^{-11}	9×10^{-3}	9×10^{-13}	3×10^{-4}
	Ac 228	S	8×10^{-8}	3×10^{-3}	3×10^{-9}	9×10^{-5}
		I	2×10^{-8}	3×10^{-3}	6×10^{-10}	9×10^{-5}
Americium (95)	Am 241	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Am 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
Antimony (51)	Sb 122	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
	Sb 124	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	2×10^{-8}	7×10^{-4}	7×10^{-10}	2×10^{-5}
	Sb 125	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	3×10^{-3}	9×10^{-10}	1×10^{-4}
Argon (18)	A 37	Sub[2]	6×10^{-3}	----------	1×10^{-4}	----------
	A 41	Sub	2×10^{-6}	----------	4×10^{-8}	----------
Arsenic (33)	As 73	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	5×10^{-4}
		I	4×10^{-7}	1×10^{-2}	1×10^{-8}	5×10^{-4}
	As 74	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	1×10^{-7}	2×10^{-3}	4×10^{-9}	5×10^{-5}
	As 76	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	As 77	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Astatine (85)	At 211	S	7×10^{-9}	5×10^{-5}	2×10^{-10}	2×10^{-6}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
Barium (56)	Ba 131	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ba 140	S	1×10^{-7}	8×10^{-4}	4×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	2×10^{-5}
Berkelium (97)	Bk 249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}	6×10^{-4}
		I	1×10^{-7}	2×10^{-2}	4×10^{-9}	6×10^{-4}
Beryllium (4)	Be 7	S	6×10^{-5}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	1×10^{-6}	5×10^{-2}	4×10^{-8}	7×10^{-3}
Bismuth (83)	Bi 206	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	1×10^{-7}	1×10^{-3}	5×10^{-9}	4×10^{-5}
	Bi 207	S	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
		I	1×10^{-7}	2×10^{-3}	5×10^{-10}	6×10^{-5}
	Bi 210	S	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
		I	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Bi 212	S	1×10^{-7}	1×10^{-2}	3×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	7×10^{-9}	4×10^{-4}
Bromine (35)	Br 82	S	1×10^{-8}	8×10^{-3}	4×10^{-8}	3×10^{-4}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Cadmium (48)	Cd 109	S	5×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
		I	7×10^{-8}	5×10^{-3}	3×10^{-9}	2×10^{-4}
	Cd 115m	S	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
	Cd 115	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Calcium (20)	Ca 45	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Ca 47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
Californium (98)	Cf 249	S	2×10^{-12}	1×10^{-4}	5×10^{-14}	4×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cf 250	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 252	S	2×10^{-11}	7×10^{-4}	7×10^{-13}	2×10^{-5}
		I	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
Carbon (6)	C 14	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO_2)	Sub	5×10^{-5}	----------	1×10^{-6}	----------
Cerium (58)	Ce 141	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}
	Ce 143	S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Ce 144	S	1×10^{-8}	3×10^{-4}	3×10^{-10}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}

See footnotes at end of table.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—continued

[See notes at end of appendix]

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Cesium (55)	Cs 131	S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs 134m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs 134	S	4×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs 135	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	9×10^{-6}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs 136	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs 137	S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl 36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl 38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr 51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}
Cobalt (27)	Co 57	S	3×10^{-5}	2×10^{-2}	1×10^{-7}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co 58m	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}
	Co 58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-8}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co 60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	9×10^{-9}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu 64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm 242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
		I	2×10^{-10}	7×10^{-4}	6×10^{-12}	3×10^{-5}
	Cm 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	5×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cm 244α	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cm 245	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 246	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
Dysprosium (66)	Dy 165	S	3×10^{-5}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
	Dy 166	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Erbium (68)	Er 169	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	Er 171	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Europium (63)	Eu 152 (T/2=9.2 hrs)	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Eu 152 (T/2=13 yrs)	S	1×10^{-8}	2×10^{-3}	4×10^{-10}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	6×10^{-10}	8×10^{-5}
	Eu 154	S	4×10^{-9}	6×10^{-4}	1×10^{-10}	2×10^{-5}
		I	7×10^{-9}	6×10^{-4}	2×10^{-10}	2×10^{-5}
	Eu 155	S	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
		I	7×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
Fluorine (9)	F 18	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
Gadolinium (64)	Gd 153	S	2×10^{-7}	6×10^{-3}	8×10^{-9}	2×10^{-4}
		I	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Gd 159	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Gallium (31)	Ga 72	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Germanium (32)	Ge 71	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
Gold (79)	Au 196	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au 198	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—continued

[See notes at end of appendix]

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Gold (79)	Au 199	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf 181	S	4×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
		I	7×10^{-8}	2×10^{-3}	3×10^{-9}	7×10^{-5}
Holmium (67)	Ho 166	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Hydrogen (1)	H3	S	5×10^{-5}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		Sub	2×10^{-3}	----------	4×10^{-5}	----------
Indium (49)	In 113m	S	8×10^{-5}	4×10^{-2}	3×10^{-7}	1×10^{-3}
		I	7×10^{-5}	4×10^{-2}	2×10^{-7}	1×10^{-3}
	In 114m	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
	In 115m	S	2×10^{-4}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	In 115	S	2×10^{-7}	3×10^{-3}	9×10^{-9}	9×10^{-5}
		I	3×10^{-8}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)	I 126	S	8×10^{-9}	5×10^{-5}	3×10^{-10}	2×10^{-6}
		I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I 129	S	2×10^{-9}	1×10^{-5}	6×10^{-11}	4×10^{-7}
		I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I 131	S	9×10^{-9}	6×10^{-5}	3×10^{-10}	2×10^{-6}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I 132	S	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I 133	S	3×10^{-8}	2×10^{-4}	1×10^{-9}	7×10^{-6}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	I 134	S	5×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I 135	S	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Iridium (77)	Ir 190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir 192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir 194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe 55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
		I	1×10^{-6}	7×10^{-2}	3×10^{-8}	2×10^{-2}
	Fe 59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	5×10^{-9}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton [2] (36)	Kr 85m	Sub	6×10^{-6}	----------	1×10^{-7}	----------
	Kr 85	Sub	1×10^{-5}	----------	3×10^{-7}	----------
	Kr 87	Sub	1×10^{-6}	----------	2×10^{-8}	----------
Lanthanum (57)	La 140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb 203	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb 210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
		I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb 212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu 177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn 52	S	2×10^{-7}	1×10^{-2}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn 54	S	4×10^{-7}	4×10^{-3}	1×10^{-9}	1×10^{-4}
		I	4×10^{-7}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn 56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Mercury (80)	Hg 197m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
		I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg 197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg 203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo 99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Neodymium (60)	Nd 144	S	8×10^{-11}	2×10^{-2}	3×10^{-12}	7×10^{-5}
		I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}

See footnotes at end of table.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—continued

[See notes at end of appendix]

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Neodymium (60)	Nd 147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd 149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}
Neptunium (93)	Np 237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	Np 239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni 59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}
		I	8×10^{-7}	6×10^{-2}	3×10^{-8}	2×10^{-3}
	Ni 63	S	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	7×10^{-4}
	Ni 65	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Niobium (Columbium) (41)	Nb 93m	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Nb 95	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb 97	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
Osmium (76)	Os 185	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	7×10^{-5}
	Os 191m	S	2×10^{-5}	7×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	7×10^{-2}	3×10^{-7}	2×10^{-3}
	Os 191	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Os 193	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	9×10^{-9}	5×10^{-5}
Palladium (46)	Pd 103	S	1×10^{-6}	1×10^{-2}	5×10^{-8}	3×10^{-4}
		I	7×10^{-7}	8×10^{-3}	3×10^{-8}	3×10^{-4}
	Pd 109	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Phosphorus (15)	P 32	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	8×10^{-8}	7×10^{-4}	3×10^{-9}	2×10^{-5}
Platinum (78)	Pt 191	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Pt 193m	S	7×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Pt 197m	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
	Pt 197	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Plutonium (94)	Pu 238	S	2×10^{-12}	1×10^{-4}	7×10^{-14}	5×10^{-6}
		I	3×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 239	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 240	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 241	S	9×10^{-14}	7×10^{-3}	3×10^{-12}	2×10^{-4}
		I	4×10^{-8}	4×10^{-2}	1×10^{-9}	1×10^{-3}
	Pu 242	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	9×10^{-4}	1×10^{-12}	3×10^{-5}
Polonium (84)	Po 210	S	5×10^{-10}	2×10^{-5}	2×10^{-11}	7×10^{-7}
		I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}
Potassium (19)	K42	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr 142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr 143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm 147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
		I	1×10^{-7}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm 149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protoactinium (91)	Pa 230	S	2×10^{-8}	7×10^{-3}	6×10^{-11}	2×10^{-4}
		I	8×10^{-10}	7×10^{-3}	3×10^{-11}	2×10^{-4}
	Pa 231	S	1×10^{-12}	3×10^{-5}	4×10^{-14}	9×10^{-7}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—continued

[See notes at end of appendix]

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Protoactinium (91)	Pa 233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra 223	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
		I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra 224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
		I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra 226	S	3×10^{-11}	4×10^{-7}	1×10^{-12}	1×10^{-8}
		I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}
	Ra 228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
		I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn 220	S	3×10^{-7}	----------	1×10^{-8}	----------
		I	----------	----------	----------	----------
	Rn 222	S	1×10^{-7}	----------	3×10^{-9}	----------
Rhenium (75)	Re 183	S	3×10^{-5}	2×10^{-2}	9×10^{-8}	6×10^{-4}
		I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re 186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re 187	S	9×10^{-6}	7×10^{-2}	3×10^{-7}	3×10^{-3}
		I	5×10^{-7}	4×10^{-2}	2×10^{-8}	2×10^{-3}
	Re 188	S	4×10^{-7}	2×10^{-2}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh 103m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	6×10^{-5}	3×10^{-1}	2×10^{-6}	1×10^{-2}
	Rh 105	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Rubidium (37)	Rb 86	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	7×10^{-8}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb 87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	7×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Ruthenium (44)	Ru 97	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Ru 103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	8×10^{-8}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru 105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru 106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Samarium (62)	Sm 147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
		I	3×10^{-10}	2×10^{-3}	9×10^{-12}	7×10^{-5}
	Sm 151	S	6×10^{-8}	1×10^{-2}	2×10^{-9}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Sm 153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc 46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc 47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc 48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Selenium (34)	Se 75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}
Silicon (14)	Si 31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag 105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	8×10^{-8}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Ag 110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag 111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na 22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na 24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr 85m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
		I	3×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
	Sr 85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}	1×10^{-4}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Sr 89	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	1×10^{-5}
		I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}

See footnotes at end of table.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—continued

[See notes at end of appendix]

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Strontium (38)	Sr 90	S	3×10^{-10}	4×10^{-6}	1×10^{-11}	1×10^{-7}
		I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Sr 91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr 92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S 35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
		I	3×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta 182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}
Technetium (43)	Tc 96m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-2}
	Tc 96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc 97m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc 97	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Tc 99m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
	Tc 99	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)	Te 125m	S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	Te 127m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te 127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Te 129m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
		I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te 129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	Te 131m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
	Te 132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)	Tb 160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)	Tl 200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl 201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl 202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl 204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}
Thorium (90)	Th 228	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	6×10^{-12}	4×10^{-4}	2×10^{-13}	10^{-5}
	Th 230	S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
		I	10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	Th 232	S	3×10^{-11}	5×10^{-5}	10^{-12}	2×10^{-6}
		I	3×10^{-11}	10^{-3}	10^{-12}	4×10^{-5}
	Th natural	S	3×10^{-11}	3×10^{-5}	10^{-12}	10^{-6}
		I	3×10^{-11}	3×10^{-4}	10^{-12}	10^{-5}
	Th 234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	3×10^{-8}	5×10^{-4}	10^{-9}	2×10^{-5}
Thulium (69)	Tm 170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
	Tm 171	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
Tin (50)	Sn 113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
	Sn 125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Tungsten (Wolfram) (74)	W 181	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	4×10^{-9}	3×10^{-4}
	W 185	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—continued

[See notes at end of appendix]

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Tungsten (Wolfram) (74)	W 187	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)	U 230	S	3×10^{-10}	1×10^{-4}	1×10^{-11}	5×10^{-6}
		I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
	U 232	S	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
		I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
	U 233	S	5×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U 234	S	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U 235	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	U 236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	1×10^{-3}	4×10^{-12}	3×10^{-5}
	U 238	S	7×10^{-11}	1×10^{-3}	3×10^{-12}	4×10^{-5}
		I	1×10^{-10}	1×10^{-3}	5×10^{-12}	4×10^{-5}
	U-natural	S	7×10^{-11}	5×10^{-4}	3×10^{-12}	2×10^{-5}
		I	6×10^{-11}	5×10^{-4}	2×10^{-12}	2×10^{-5}
Vanadium (23)	V 48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
		I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)	Xe 131m	Sub	2×10^{-5}	----------	4×10^{-7}	----------
	Xe 133	Sub	1×10^{-5}	----------	3×10^{-7}	----------
	Xe 135	Sub	4×10^{-6}	----------	1×10^{-7}	----------
Ytterbium (70)	Yb 175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Yttrium (39)	Y 90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	Y 91m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
		I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
	Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
		I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y 92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Y 93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Zinc (30)	Zn 65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn 69m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Zn 69	S	7×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	9×10^{-6}	5×10^{-2}	3×10^{-7}	2×10^{-3}
Zirconium (40)	Zr 93	S	1×10^{-7}	2×10^{-2}	4×10^{-9}	8×10^{-4}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Zr 95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-5}
	Zr 97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}

[1] Soluble (S); Insoluble (I).

[2] "Sub" means that values given are for submersion in an infinite cloud of gaseous material.

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, and 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 values for purposes of Appendix B shall be:

a. For purposes of Table I, Col. 1—1×10^{-12}
b. For purposes of Table I, Col. 2—3×10^{-7}
c. For purposes of Table II, Col. 1—4×10^{-14}
d. For purposes of Table II, Col. 2—1×10^{-8}

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

Element (atomic number) and isotope	Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
If it is known that Sr 90, I 129, Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, and Th-nat are not present	----------	9×10^{-5}	----------	$3\times10^{-}$
If it is known that Sr 90, I 129, Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, and Th-nat are not present	----------	6×10^{-5}	----------	2×10^{-6}
If it is known that Sr 90, Pb 210, Ra 226 and Ra 228 are not present	----------	2×10^{-5}	----------	6×10^{-7}
If it is known that Ra 226 and Ra 228 are not present	----------	3×10^{-6}	----------	1×10^{-7}
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241 and Bk 249 are not present	3×10^{-9}	----------	1×10^{-10}	----------
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-10}	----------	1×10^{-11}	----------
If it is known that alpha-emitters and Ac 227 are not present	3×10^{-11}	----------	1×10^{-12}	----------
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, and Cf 249 are not present	3×10^{-12}	----------	1×10^{-13}	----------
If Pa 231, Pu 239, Pu 240, Pu 242 and Cf 249 are not present	2×10^{-12}	----------	7×10^{-14}	----------

APPENDIX C

Material	Microcuries
Ag^{105}	1
Ag^{111}	10
As^{76}, As^{77}	10
Au^{198}	10
Au^{199}	10
$Ba^{140}+La^{140}$	1
Be^{7}	50
C^{14}	50
Ca^{45}	10
$Cd^{109}+Ag^{109}$	10
$Ce^{144}+Pr^{144}$	1
Cl^{36}	1
Co^{60}	1
Cr^{51}	50
$Cs^{137}+Ba^{137}$	1
Cu^{64}	50
Eu^{154}	1
F^{18}	50
Fe^{55}	50
Fe^{59}	1
Ga^{72}	10
Ge^{71}	50
H^{3}(HTO or H_2O)	250
I^{131}	10
In^{114}	1
Ir^{192}	10
K^{42}	10
La^{140}	10
Mn^{52}	1
Mn^{56}	50
Mo^{99}	10
Na^{22}	10
Na^{24}	10
Nb^{95}	10
Ni^{59}	1
Ni^{63}	1
P^{32}	10
$Pd^{103}+Rh^{103}$	50
Pd^{109}	10
Pm^{147}	10
Po^{210}	0.1
Pr^{143}	10
Pu^{239}	1
Ra^{226}	0.1
Rb^{86}	10
Re^{186}	10
Rh^{105}	10
$Ru^{106}+Rh^{106}$	1
S^{35}	50
Sb^{124}	1
Sc^{46}	1
Sm^{153}	10
Sn^{113}	10
Sr^{89}	1
$Sr^{90}+Y^{90}$	0.1
Ta^{182}	10
Tc^{96}	1
Tc^{99}	1
Te^{127}	10
Te^{129}	1
Th (natural)	50
Tl^{204}	50
Tritium. See H^3	250
U (natural)	50
U^{233}	1
U^{234}-U^{238}	50
V^{48}	1
W^{185}	10
Y^{90}	1
Y^{91}	1
Zn^{65}	10
Unidentified radioactive materials or any of the above in unknown mixtures	0.1

NOTE: For purposes of §§ 20.203 and 20.304, 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").

EXAMPLE: For purposes of § 20.304, if a particular batch contains 2,000 μc of Au^{198} and 25,000 μc of C^{14}, it may also include not more than 3,000 μc of I^{131}. This limit was determined as follows:

$$\frac{2{,}000\ \mu c\ Au^{198}}{10{,}000\ \mu c}+\frac{25{,}000\ \mu c\ C^{14}}{50{,}000\ \mu c}+\frac{3{,}000\ \mu c\ I^{131}}{10{,}000\ \mu c}=1$$

The denominator in each of the above ratios was obtained by multiplying the figure in the table by 1,000 as provided in § 20.304.

APPENDIX D

UNITED STATES ATOMIC ENERGY COMMISSION OPERATION OFFICES

Operations office	Operations office address	Telephone
1. New York Operations Office	376 Hudson Street, New York 14, N.Y.	Yukon 9-1000.
2. Oak Ridge Operations Office	P.O. Box E, Oak Ridge, Tenn	Oak Ridge 5-7486 or 5-8611, Ext. 7607.
3. Savannah River Operations Office	P.O. Box A, Aiken, S.C	Aiken, S.C., Midway 9-6211; or Augusta, Ga., Park 4-6311, Ext. 3333.
4. Albuquerque Operations Office	P.O. Box 5400, Albuquerque, N. Mex.	Alpine 6-4411, Ext. 38267.
5. Chicago Operations Office	9800 South Cass Avenue, Argonne, Ill.	Clearwater 7-7711, Ext. 2111 or 541.
6. Idaho Operations Office	P.O. Box 2108, Idaho Falls, Idaho	Jackson 2-6640.
7. San Francisco Operations Office	2111 Bancroft Way, Berkeley 4, Calif.	Thornwall 1-5620.
8. Hanford Operations Office	P.O. Box 550, Richland, Wash	Whitehall 2-1111, Ext. 6-5441.

NOTE: The record keeping and reporting requirements contained in this part have been approved by the Bureau of the Budget in accordance with the Federal Reports Act of 1942.

Dated at Germantown, Md., this 8th day of November 1960.

For the Atomic Energy Commission,

W. B. MCCOOL,
Secretary.

[F.R. Doc. 60-10676; Filed, Nov. 16, 1960; 8:45 a.m.]

U.S. GOVERNMENT PRINTING OFFICE: 1960 O - 576148

(Published in 26 Federal Register, 11046, November 25, 1961)

Title 10—ATOMIC ENERGY

Chapter I—Atomic Energy Commission

PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

Concentration Limits in Radionuclide Mixtures

On pages 7142 and 7143 of the FEDERAL REGISTER of August 9, 1961 there was published a notice of proposed rule making to amend 10 CFR 20, "Standards for Protection Against Radiation", which would amend the Note to Appendix "B" of Part 20 to provide an additional standard for deriving a concentration limit for any mixture of radionuclides (1) where the identity of each radionuclide in the mixture is known but the concentration of each radionuclide in the mixture is not known, or (2) where the identity of each radionuclide in the mixture is not known but where it can be demonstrated by assay or by the process of elimination that radionuclides other than those presently specified in the Note are not present.

The amendment also specifies criteria for determining conditions under which radionuclides may be considered as not present in a mixture.

Interested persons were given 60 days in which to submit written comments in conection with the proposed amendments. No objections or suggested changes to the proposed amendment have been received by the Commission.

Pursuant to the Atomic Energy Act of 1954, as amended, and the Administrative Procedure Act of 1946, the proposed amendments of 10 CFR Part 20 are adopted, without change, as a document subject to codification.

Effective date. These amendments shall become effective 30 days after publication in the FEDERAL REGISTER.

Dated at Germantown, Maryland, this 15th day of November 1961.

For the Atomic Energy Commission.

WOODFORD B. MCCOOL,
Secretary.

Part 20 is amended as follows:

1. Revise paragraph 3 of the Appendix "B" Note to read:

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 isotope	Table I		Table II	
	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
If it is known that Sr 90, I 129, Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, and Th-nat are not present	----------	9×10^{-5}	----------	3×10^{-6}
If it is known that Sr 90, I 129, Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, and Th-nat are not present	----------	6×10^{-5}	----------	2×10^{-6}
If it is known that Sr 90, Pb 210, Ra 226 and Ra 228 are not present	----------	2×10^{-5}	----------	6×10^{-7}
If it is known that Ra 226 and Ra 228 are not present	----------	3×10^{-6}	----------	1×10^{-7}
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241 and Bk 249 are not present	3×10^{-9}	----------	1×10^{-10}	----------
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-10}	----------	1×10^{-11}	----------
If it is known that alpha-emitters and Ac 227 are not present	3×10^{-11}	----------	1×10^{-12}	----------
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, and Cf 249 are not present	3×10^{-12}	----------	1×10^{-13}	----------
If Pa 231, Pu 239, Pu 240, Pu 242 and Cf 249 are not present	2×10^{-12}	----------	7×10^{-14}	----------

2. Add the following paragraph 5 to the Appendix "B" Note:

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 1/10, (i.e. $\frac{C_A}{MPC_A} \leqq \frac{1}{10}$) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed 1/4 i.e.

$$\frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \ldots\ldots \leqq \tfrac{1}{4}).$$

[F.R. Doc. 61-11157; Filed, Nov. 24, 1961; 8:45 a.m.]

(Published in 26 Federal Register, 10770, November 17, 1961)

Title 10—ATOMIC ENERGY

Chapter I—Atomic Energy Commission

PART 2—RULES OF PRACTICE

Notice to Local Officials

On June 7, 1961, the Atomic Energy Commission published in 26 F.R. 5077 for public comment certain proposed amendments to 10 CFR Part 2 to provide for (1) formal notice to local officials of the filing of applications for certain facility and waste disposal licenses and amendments to such licenses; and (2) notices of hearings to be given by the Commission to the Governor, or other appropriate official of the State and the chief executive in the locality in which the facility is to be located or the activity to be conducted. Comments filed by interested persons have been given consideration. Certain modifications have been made for purposes of clarification.

Pursuant to the Administrative Procedure Act and the Atomic Energy Act of 1954, as amended, the following rules are published as a document subject to codification to be effective thirty days after publication in the FEDERAL REGISTER.

1. Section 2.101 is amended by redesignating the present text of that section as paragraph (b), revising the heading of that section, and adding a new paragraph (a) to read as follows:

§ 2.101 Notice of application, administrative examination of applications, informal conferences.

(a) A copy of an application or amendment to an application for a facility construction permit or license or an authorization subject to Part 115, or for a license to receive waste material from other persons for the purpose of packaging, storage or disposal, shall be served by the applicant on (1) the chief executive of the municipality in which the facility is to be located or the activity is to be conducted, or (2) if the facility is not to be located or the activity conducted within a municipality, then on the chief executive of the county. The AEC will send a copy of each such application or amendment to the Governor or other appropriate official of the State in which the facility is to be located or the activity is to be conducted.

§ 2.735 [Amendment]

2. Paragraph (a) of § 2.735 is amended to read as follows:

(a) Whenever a hearing is granted, AEC will give timely notice of the hearing to all parties and to other persons, if any, entitled by law to notice. Notice of hearing on an application or amendment to an application for a facility construction permit or license or an authorization subject to Part 115, or for a license to receive waste material from other persons for the purpose of packaging, storage or disposal, will be given (1) to the Governor or other appropirate official of the State and the chief executive of the municipality in which the facility is to be located or the activity is to be conducted, or (2), if the facility is not to be located or the activity conducted within a municipality, then to the chief executive of the county. Every notice of hearing will state the time, place, and nature of the hearing; the legal authority and jurisdiction under which the hearing is to be held; the matters of fact and law asserted or to be considered, which will be identified as the "Specification of Issues"; and a request for an answer. The time and place for hearing will be fixed with due regard for the convenience and necessity of the parties or their representatives.

Dated at Germantown, Md., this 9th day of November 1961.

For the Atomic Energy Commission.

WOODFORD B. MCCOOL,
Secretary.

[F.R. Doc. 61-10937; Filed, Nov. 16, 1961; 8:45 a.m.]

(Reprinted in 27 Federal Register, 1350, February 14, 1962)

Title 10—ATOMIC ENERGY

Chapter I—Atomic Energy Commission

PART 30—LICENSING OF BYPRODUCT MATERIAL

Miscellaneous Amendments

The Commission is today publishing in the FEDERAL REGISTER a new regulation entitled, "Part 150—Exemptions and Continued Regulatory Authority in Agreement States under Section 274." That part contains provisions granting a general license to any person who holds a specific license from an agreement State to conduct the same activity in a nonagreement State, provided that specific license does not limit the activity authorized by the specific license to specified installations or locations. In adopting Part 150 the Commission concluded that it would also be desirable to extend the general licenses contained in § 30.21(c) of this part to devices manufactured under specific licenses issued by agreement States. The following amendments to Part 30 are designed to accomplish that purpose and reflect comments received by the Commission from interested persons and organizations in response to the notice of proposed adoption of Part 150 published by the Commission in the FEDERAL REGISTER on September 29, 1961.

The Commission will welcome suggestions and comments for further changes in these rules, which should be submitted to the Secretary, U.S. Atomic Energy Commission, Washington 25, D.C.

Pursuant to the Atomic Energy Act of 1954, as amended and the Administrative Procedure Act of 1946, the following amendments to 10 CFR Part 30 are published as a document subject to codification, to be effective on publication in the FEDERAL REGISTER.

1. The following paragraph is added to § 30.4:

*(t) "Agreement State" as designated in Part 150 of this chapter means any State with which the Commission has entered into an effective agreement under subsection 274.(b) of the Atomic Energy Act of 1954, as amended. "Nonagreement State" means any other State.

2. Paragraph (c) of § 30.21 is amended to read as follows:

(c) (1) Subject to the provisions of subparagraphs (2) to (6) of this paragraph (c), a general license is hereby issued to own, receive, acquire, possess and use byproduct material when contained in devices designed and manufactured for the purpose of detecting, measuring, gauging or controlling thickness, density, level, interface location, radiation, leakage, or qualitative or quantitative chemical composition, or for producing light or an ionized atmosphere.

(2) The general license contained in subparagraph (1) of this paragraph (c) applies only to devices which have been:

(i) Manufactured in accordance with the specifications contained in a specific license issued by the Commission to the manufacturer of the device pursuant to § 30.24(f), or, in accordance with the specifications contained in a specific license issued to the manufacturer by an agreement State; and

(ii) Installed on the premises of the general licensee by a person authorized to install such devices under a specific license issued to the installer by the Commission pursuant to this part or by an agreement State, provided that the specific license referred to in subdivision (i) of this subparagraph (2) contains provisions authorizing the transfer of such devices to, and the installation of such devices in the premises of, general licensees.

(3) The general license contained in subparagraph (1) of this paragraph (c) applies only to devices which (i) are labeled in accordance with the provisions of the specific license which authorizes the distribution of the device to general licensees, and (ii) bear a label containing the following or a substantially similar statement which contains the information called for in the following statement:

This device, generally licensed pursuant to § 30.21(c) of 10 CFR, Part 30, has been manufactured and distributed pursuant to license No. _____ issued by _____ (insert either "Atomic Energy Commission" or name of agreement State, whichever is applicable)

_____
(Name of supplier)

(4) Persons who own, receive, acquire, possess or use a device pursuant to the general license contained in subparagraph (1) of this paragraph (c):

(i) Shall not transfer, abandon or dispose of the device, except by transfer to a person authorized by a specific license from the Commission or an agreement State to receive such device;

(ii) Shall assure that all labels affixed to the device at the time of receipt and bearing the statement, "Removal of this label is prohibited by regulations of the Atomic Energy Commission", are maintained thereon and shall comply with all instructions contained in such labels;

(iii) Shall have the device tested for leakage of radioactive material and proper operation of the on-off mechanism and indicator, if any, at no longer than six-month intervals; provided that devices containing only krypton need not be tested for leakage, and devices containing only tritium need not be tested for any purpose;

(iv) Shall have the tests required by subdivision (iii) of this subparagraph and all other services involving the radioactive material, its shielding and containment, performed by the supplier or other person holding a specific license from the Commission or an agreement State to manufacture, install or service such devices;

(v) Shall maintain records of all tests performed on the devices as required under this section, including the dates and results of the tests and the names of the persons conducting the tests;

(vi) Upon the occurrence of a failure of or damage to, or any indication of a possible failure of or damage to, the shielding or containment of the radioactive material or the on-off mechanism or indicator, shall immediately suspend operation of the device until it has been repaired by the supplier or other person holding a specific license from the Commission or an agreement State to manufacture, install or service such devices, or disposed of by transfer to a person authorized to receive the byproduct material contained in the device; and

(vii) Shall be exempt from the requirements of Part 20 of this chapter, except that such persons shall comply with the provisions of §§ 20.402 and 20.403 of this chapter.

(5) The general license provided in subparagraph (1) of this paragraph (c) is subject to the provisions of §§ 30.32 to 30.72, inclusive: *Provided*, That persons who possess byproduct material pursuant to this general license shall not export such byproduct material without a specific license from the Commission authorizing such export.

(6) Any person who holds a specific license issued by an agreement State authorizing the holder to manufacture, install or service a device described in subparagraph (1) of this paragraph (c) within such agreement State is hereby granted a general license to install and service such device in any nonagreement State; *Provided*, That:

(i) Such person shall file a report with the Director, Division of Licensing and Regulation, Atomic Energy Commission, Washington 25, D.C., within 30 days after the end of each calendar quarter in which any device is transferred or installed. Each such report shall identify each general licensee by name and address, the type of device transferred, and the quantity and type of byproduct material contained in the device.

(ii) The device has been manufactured, labelled, installed, and serviced in

*ERRATUM: Reference should be (u) instead of (t)

accordance with applicable provisions of the specific license issued to such person by the agreement State;

(iii) Such person assures that any labels required to be affixed to the device under regulations of the agreement State which licensed manufacture of the device bear a statement that "Removal of this label is prohibited by the regulations of the Atomic Energy Commission".

(iv) Shall furnish to each general licensee to whom he transfers such device or on whose premises he installs such device a copy of the general license contained in § 30.21(c).

(Secs. 81, 161, 274, 68 Stat. 935, 948, 73 Stat. 688; 42 U.S.C. 2111, 2201, 2021)

Dated at Germantown, Md., this 7th day of February 1962.

For the Atomic Energy Commission.

WOODFORD B. MCCOOL,
Secretary.

[F.R. Doc. 62-1498; Filed, Feb. 13, 1962; 8:50 a.m.]

(Reprinted in 27 Federal Register, 531, January 18, 1962)

ATOMIC ENERGY COMMISSION

[10 CFR Part 30]

EXEMPTION OR GENERAL LICENSING OF CERTAIN BYPRODUCT MATERIALS FOR MEDICAL USE

Notice of Proposed Rule Making

A number of byproduct materials, such as iodine 131, phosphorus 32, chromium 51, cobalt 58, and cobalt 60, have been used for medical purposes for several years. Considerable experience has been obtained also with various devices containing byproduct material.

The Commission considers that the uses, contraindications, and necessary precautionary measures for safe handling of certain of these byproduct materials and devices have been determined. It appears feasible and desirable, therefore, to exempt physicians from the licensing requirements of Part 30 for relatively small quantities of certain byproduct materials. It also appears feasible and desirable to issue a general license to physicians for larger quantities of these byproduct materials if appropriate radiation safety limitations are made a condition of the general license.

The proposed amendments would exempt the use for diagnostic purposes by physicians of iodine 131, cobalt 58, cobalt 60, and chromium 51 in specified forms and relatively small quantities. A general license would be established for the medical use of iodine 131 and phosphorus 32 in specified forms and limited quantities sufficient for certain therapeutic and diagnostic uses. The exemption and this general license would apply only to byproduct material obtained from a supplier holding (a) an effective new drug application, or license issued by the Secretary, Department of Health, Education, and Welfare, and (b) a license issued by the Atomic Energy Commission under § 30.24(k) of the proposed amendment. A general license would be established also for needles and tubes containing cobalt 60.

The exemption and general licenses would apply only to physicians defined in 10 CFR 30.4(i) as "* * * an individual licensed by a state or territory of the United States, the District of Columbia or the Commonwealth of Puerto Rico to dispense drugs in the practice of medicine." Cobalt 60 needles and tubes would be generally licensed for use by a physician who has at least three years of experience in the interstitial or intracavitary use of sealed sources containing radioactive materials, and who certifies to the Commission that he is familiar with the hazards and appropriate precautions associated with such sealed sources.

The general licensees would be required to register with the Commission and receive a registration number prior to obtaining the byproduct material or device for use under the general license. The conditions to which the general license would be subject will be reproduced upon the Registration Certificate. Thus, he will be informed of the conditions of the general license.

The proposed amendments also would establish licensing criteria for persons proposing to distribute byproduct material for use by physicians who would be exempted or generally licensed by the amendment.

STATEMENT OF RADIATION SAFETY CONSIDERATIONS

Section 30.11: Under the provisions of the exemption in § 30.11 the pharmaceutical containing radioactive material would be packaged in individual cali-

brated doses ready for administration. No processing by the physician would be required. The radioisotopes would be used only by physicians and for medical diagnosis. The proposed exemption requires that the radioactive material be stored, until administered, in the original shipping container or a container providing equivalent radiation protection. The maximum quantities of radioactive material which a physician could possess at any one time under the exemption would be 200 microcuries of iodine 131; 10 microcuries of cobalt 58; 10 microcuries of cobalt 60; and 200 microcuries of chromium 51.

The radiation doses received by physicians or technicians in the administration and handling of diagnostic doses of radioisotopes which would be exempted are quite small. Interstate Commerce Commission regulations specify that the radiation on the surface of a shipping container shall not exceed 200 milliroentgens per hour (mr/hr) and at one meter from the contained radioactive material shall not exceed 10 mr/hr. In practice, the radiation levels about containers of diagnostic doses of isotopes are much less than these maximum allowable levels. The radioisotope container is handled by physicians and technicians for very short periods of time. Remote handling equipment is unnecessary. The dose rate at a distance of one centimeter from a point source of 200 microcuries of iodine 131 is about 440 mr/hr or 7.3 mr/minute. A bottle of iodine 131 capsules is not a point source, but the dose rate close to it would be of this order of magnitude.

The dose rates from the other diagnostic radioisotopes which would be exempted will be much lower than for iodine 131. The dose rates at one centimeter from point sources of 10 microcuries of cobalt 58, 10 microcuries of cobalt 60 and 200 microcuries of chromium 51 are 60 mr/hr, 128 mr/hr and 80 mr/hr, respectively.

10 CFR Part 20 specifies that the hands of radiation workers may be exposed to 18¾ rems per quarter or an average dose of 1440 millirem per week. If an individual were exposed only through the handling of 200 microcuries of iodine 131, he could handle the cup or bottle containing the radioisotope $\frac{1440}{7.3}=198$ minutes each week without exceeding the limiting hand dose established by 10 CFR Part 20. In practice, diagnostic doses of radioisotopes are handled only one or two minutes during each administration and in a large diagnostic program perhaps no more than ten cases a week would be involved. The hand doses received by physicians and technicians from handling diagnostic doses of radioisotopes are small.

The whole body exposures to medical personnel are likewise small from the handling of these doses. The dose rate at one foot from 200 microcuries of unshielded iodine 131, 10 microcuries of unshielded cobalt 58, 10 microcuries of unshielded cobalt 60 and 200 microcuries of unshielded chromium 51 are 0.5 mr/hr, 0.06 mr/hr, 0.14 mr/hr and 0.09 mr/hr, respectively. Doses received by physicians and technicians who work in the radioisotope diagnostic programs are so small that personnel monitoring equipment is not required under the provisions of § 20.202 of 10 CFR Part 20.

Because of the low levels of radiation involved and the manner in which diagnostic radioisotopes are used, there is no need to specify minimum training or experience requirements for physicians. Further, a radiation survey meter is not needed. In the case of accidental spills, which are infrequent, the radiation instrumentation used by the licensee to interpret results of the diagnostic tests can be used to check for contamination. There is little likelihood that the radioisotopes will be ingested or inhaled by medical personnel since no processing of the radioisotopes will be involved. Since diagnostic radioisotopes are ordered by physicians on an as needed basis, very little of the material is disposed of as waste.

Section 30.26: Iodine 131 and phosphorus 32 which would be generally licensed under § 30.26 would be packaged in individual doses ready for administration. No additional processing of the material would be required and the radioisotopes would be used only by physicians and only for medical diagnosis or therapy. The maximum quantities of radioactive material which a physician could possess at any one time under this general license would be 15 millicuries of iodine 131 and 10 millicuries of phosphorus 32.

Since phosphorus 32 is a pure beta emitter, the radiation dose rates received by the hands of persons who handle this isotope in closed containers is quite low. The bremsstrahlung dose rate through the walls of a glass bottle containing 5 millicuries of the isotope is about 0.5 mr/hr at 10 centimeters from the bottle. The surface dose rate could be as high as $0.5\times(10)^2=50$ mr/hr. Quimby [1] found that the dose rate at the mouth of an "open" bottle with a 3 square centimeter area and 5 centimeters deep, containing 10 millicuries of phosphorus 32 was as high as 100 rads per hour. Hence, precautions must be taken when handling this isotope to assure that the hands are not overexposed. However, because of the type of container in which the isotope is received and the manner in which the material is used, the radiation doses to physicians and technicians working with phosphorus 32 are normally low.

The radiation levels outside of the bodies of patients who have been given phosphorus 32 are quite low. There is no external hazard to nursing personnel who care for such patients. Instructions for nursing personnel are standardized with respect to precautions to be observed in the event the patient should vomit after oral administration and precautions to be observed regarding excreta.

Therapeutic doses of iodine 131 are normally handled with forceps or tongs to reduce the radiation exposure. The dose rate at the surface of an unshielded bottle containing 15 millicuries of iodine 131 could be as high as 0.55 roentgens per minute. The provisions of the general license would, in effect, require that the iodine 131 be kept in a shielded container which would reduce the radiation level at the container surface to 200 mr/hr and at one meter from the contained radioactive material 10 mr/hr. Because of the shielding of the storage container and the routine manner in which the material is used, the radiation doses to physicians and technicians working with the material are kept well below the exposure limits of 10 CFR Part 20.

Special precautions are required in the handling of patients containing therapeutic levels of iodine 131 with respect to external radiation in the vicinity of the patient and with respect to vomitus and excreta. Extrapolating calculations given by Quimby,[1] the maximum dose which a nurse would be expected to receive while caring for a patient containing 15 millicuries of iodine 131 for six days would be about 25 millirem to the whole body and 250 millirem to the hands. A special duty nurse would be expected to receive a whole body exposure of about 50 millirem during the same period because of the extra time spent in the room.

The general license would apply only to iodine 131 and phosphorus 32 in capsules or other forms of prepackaged individual doses. Capsule form reduces the possibility of radio-contamination if the pharmaceutical is dropped. Suppliers of the general licensed radioisotopes would be required under the provisions of § 30.24(k) to provide the general licensee with instructions as to the precautions to be observed in handling this material. These instructions would be approved by the Commission's staff prior to issuance of a license to the supplier authorizing him to distribute radioisotopes to general licensees. With the safety instructions issued by the radioisotope supplier, these radioisotopes should be used in a safe manner.

Because of the high levels of radiation associated with millicurie amounts of unshielded phosphorus 32 and iodine 131, and possible contamination which could result from vomitus and excreta, a radiation survey instrument is considered necessary for use by the general licensee at all times to assure the safe use of this material.

As in the case of diagnostic radioisotopes, therapeutic doses are ordered by physicians on an as needed basis. Consequently, very little waste material results. Because of the short half-lives of iodine 131 and phosphorus 32 any contaminated equipment, including bedding, can be stored until the radioactivity has decayed to safe amounts.

The proposed general license of § 30.26 would not require the hospitalization of patients containing radioisotopes. The levels of radiation about patients containing phosphorus 32 are very low. Those about patients containing iodine 131 are substantial but are not considered sufficiently high to warrant hospitalization. Such patients are permitted to return home after adminis-

[1] Quimby, Edith H., "Safe Handling of Radioactive Isotopes in Medical Practice," The MacMillan Company (1960).

tration under present specific licensing procedures. The dose rate at one foot from the thyroid of a patient who is administered 30 millicuries of iodine 131 is initially less than 20 mr/hr. Approximately 50 percent of the radioisotope is eliminated by urinary excretion during the first 48 hours and thereafter the radioisotope is reduced 50 percent each week due to biological and radiological decay.[1]

The general license would require each physician who proposes to receive byproduct material under the provisions of the general license to register with the Commission prior to receiving the byproduct material. Registration will provide the Commission with the names and addresses of the generally licensed physicians so that inspections may be conducted by the AEC.

Section 30.28: Cobalt 60 was one of the first artificial radioisotopes to be used therapeutically, since it seemed to be the most suitable replacement for radium.[2] Needles or tubes of this radioisotope are used to supplement or replace radium in intracavitary or interstitial treatments. The dosage delivered by 0.646 millicuries of cobalt 60 is the same in roentgens per hour as that delivered by one milligram of radium filtered by 0.5 mm of platinum.[3] The procedures for cobalt 60 therapy are essentially the same as for radium. Cobalt 60 is a relatively corrosion resistant metal while radium is a powder (radium sulfate). Absorbed cobalt 60 is rapidly excreted while radium may be deposited in the bone.

Cobalt 60 needles are prepared by hermetically sealing small segments of cobalt 60 wire in stainless steel tubing and other corrosion resistant metals. They are essentially the same size as radium needles. Needles are placed directly in the tumor mass with thread or wire by which they may be withdrawn after the desired dosage has been delivered.

There are five stages during which radiation hazards may exist during the use of cobalt 60. These are listed below along with a discussion of each.

1. *Storage and transfer from storage.* Under the provisions of the proposed general license the cobalt 60 must be stored in the shielded storage case in which the cobalt 60 is received or a container providing equivalent radiation protection. The maximum radiation level on the surface of the container would be 200 mr/hr and at 1 meter from the contained radioactive material 10 mr/hr. The sources are prepared for use with the aid of remote handling tools behind shields. The need for shielding and remote manipulators is evident inasmuch as the dose rate at one foot from 100 millicuries of unshielded cobalt 60 is 1.4 r/hr. Procedures for transfer are well established because of the experience gained over several years in the use of radium.

2. *Application to patient.* Cobalt 60 sources are normally applied to patients in the operating room. They are transferred to the operating room in their shielded container and placed in the patient by use of remote manipulators. The time required to insert sources in patients is kept at a minimum since the methods of implant are determined in advance. Sources are packed in place with dressings and special appliances to assure that sources are not accidentally extruded from the patient.

3. *Irradiation of patient.* Procedures for caring for patients with cobalt 60 implants are well established. Special instructions are required for nursing personnel to advise them of safe distances and times to spend in the vicinity of the patient, and to inform them of what should be done if a tube or needle should be extruded from the patient. Under the provisions of the general license the physician would be supplied such instructions by the supplier of the byproduct material.

Because of the high dose rates about patients containing cobalt 60 needles or tubes, the proposed general license would require hospitalization of the patient until the byproduct material is removed. The dose rate at three feet from a patient containing 100 millicuries of the isotope may be as high as 155 mr/hr. A radioisotope record card containing the radiation caution symbol would be required to be attached to the patient's bed or to the door of the room in which the patient is hospitalized. The card would accompany the patient whenever he leaves his room as long as the radioisotope is contained in his body. The card would serve to give warning to anyone performing services for the patient in order to minimize their radiation exposures.

4. *Removal of sources.* Sources may be removed in the operating room or at the patient's bedside. They are immediately returned to the storage container. Special care must be taken when removing the sources to assure that all sources placed in the patient are accounted for. The proposed general license would require that a physical inventory of the cobalt 60 needles or tubes be conducted after each use to account for all byproduct material used.

5. *Dismantling of cobalt 60 applicator and return to stock.* Following removal of the sources from the patient, the applicator is dismantled behind shielding with remote manipulators, cleaned and returned to the shielded container for future use. These procedures are well established.

Because of the high levels of radiation associated with the millicurie amounts of cobalt 60 which would be used, the general license would require the licensee to maintain and use a calibrated radiation survey instrument in his program. The instrument would also be useful to locate any source which is accidentally extruded from a patient.

The provisions of the general license require that the sealed source shall be tested for leakage at twelve-month intervals, and specify what should be done in event a leaking source is found. The manufacturer of the sealed sources would be required to test sources following manufacture to assure that they are properly sealed. Also, each source must be individually calibrated and marked by the manufacturer so as to identify the number of millicuries and linear intensity of each needle or tube.

Any physician who proposes to receive byproduct material under general license would be required to register with the Commission prior to receiving the material. The general licensee would not be permitted to transfer, abandon or dispose of the radioisotope except by transfer to a person generally or specifically licensed to receive the material. Further, persons who manufacture and distribute cobalt 60 under the provisions of § 30.24(1) would be required by § 30.32 (g) to inform the Commission of all transfers of cobalt 60 to general licensees. Because of the possible hazards of the radioisotope in the hands of an untrained person, the reporting requirements are considered necessary. Further, this will enable the Commission to perform inspections of the general licensed physician.

Pursuant to the Atomic Energy Act of 1954, as amended, and the Administrative Procedure Act of 1946, notice is hereby given that adoption of the following amendments to Part 30 is contemplated. All interested persons who desire to submit written comments or suggestions in connection with the proposed amendments should send them to the Secretary, United States Atomic Energy Commission, Washington 25, D.C., within ninety (90) days after publication of this notice in the FEDERAL REGISTER. Comments received after that period will be considered if it is practicable to do so, but assurance of consideration cannot be given except as to comments filed within the period specified.

1. A new § 30.11 is added to read as follows:

§ 30.11 Exemption of certain quantities of byproduct material for medical use.

(a) A physician is exempt from the requirements for a license set forth in section 81 of the Act and from the regulations in this part to the extent that he receives, possesses, uses or transfers in accordance with the provisions of paragraphs (b), (c), and (d) of this section the following byproduct materials:

(1) Iodine 131 in capsules, disposable hypodermic syringes or other forms of prepackaged individual doses.

(2) Cobalt 58 in capsules or other forms of prepackaged individual doses.

(3) Cobalt 60 in capsules or other forms of prepackaged individual doses.

(4) Chromium 51.

(b) A physician shall not possess at any one time, pursuant to the exemption in paragraph (a) of this section more than:

(1) 200 microcuries of iodine 131, and
(2) 10 microcuries of cobalt 58, and
(3) 10 microcuries of cobalt 60, and
(4) 200 microcuries of chromium 51.

[1] Quimby, Edith H., "Safe Handling of Radioactive Isotopes in Medical Practice," The MacMillan Company (1960).
[2] Blahd, William H., et al., "The Practice of Nuclear Medicine," Charles C. Thomas (1958).
[3] Quimby, Edith H., et al., "Radioactive Isotopes in Clinical Practice," Lea and Febiger (1958).

(c) The exemption in paragraph (a) of this section is effective only when:

(1) The container of the pharmaceutical bears a label which includes the following statement: "This pharmaceutical may be distributed to physicians under license exemption of the U.S. Atomic Energy Commission."

(2) The byproduct material is stored, until administered, in the original shipping container or in a container providing equivalent radiation protection.

(d) A physician who possesses byproduct material under the exemption in this section:

(1) Shall use the pharmaceutical received pursuant to the exemption in paragraph (a) of this section only for those uses described in the label or brochure accompanying the package.

(2) Shall not transfer, abandon, or dispose of the byproduct material except by transfer to a person authorized to receive the byproduct material pursuant to a specific license issued by the Commission or pursuant to the exemption in paragraph (a) in this section or the general license in § 30.26(a).

(3) Shall not transfer the byproduct material to another person except in the unopened, labeled shipping container as received from the supplier.

2. A new § 30.26 is added to read as follows:

§ 30.26 General license, certain diagnostic and therapeutic quantities.

(a) A general license is hereby issued to any physician to receive, possess, use, or transfer in accordance with the provisions of paragraphs (b), (c), and (d) of this section the following byproduct materials:

(1) Iodine 131 in capsules or other forms of prepackaged individual doses.

(2) Phosphorus 32 in capsules or other forms of prepackaged individual doses.

(b) No physician shall receive, possess, use, or transfer byproduct material pursuant to the general license established by paragraph (a) of this section until he has:

(1) Filed Form AEC 482, "Registration Certificate—Medical Use of Byproduct Material Under General License" in triplicate with the Director, Division of Licensing and Regulation, U.S. Atomic Energy Commission, Washington 25, D.C., and

(2) Received from the Commission a validated copy of the Form AEC-482 with registration number assigned.

(c) A physician who receives a pharmaceutical containing byproduct material pursuant to the general license established by paragraph (a) of this section shall comply with the following:

(1) He shall not possess at any one time, pursuant to the general license in paragraph (a) of this section, more than:

(i) 15 millicuries of iodine 131 in capsules or other forms of prepackaged individual doses, and

(ii) 10 millicuries of phosphorus 32 in capsules or other forms of prepackaged individual doses.

(2) He shall not receive, possess, or use the pharmaceutical pursuant to the general license in paragraph (a) of this section, unless the container bears a label which includes the following statement: "This pharmaceutical may be distributed to physicians pursuant to general license 10 CFR 30.26 of the U.S. Atomic Energy Commission."

(3) He shall use the pharmaceutical received pursuant to the general license in paragraph (a) of this section only for those uses described in the label or brochure accompanying the package.

(4) He shall not transfer, abandon, or dispose of the pharmaceutical except:

(i) By transfer to a person authorized to receive the byproduct material pursuant to a specific license issued by the Commission or pursuant to the general license in paragraph (a) of this section.

(ii) By release into a sanitary sewerage system: *Provided, however,* That the total quantity of byproduct material released into the sanitary sewerage system by the general licensee does not exceed more than 100 microcuries in any twenty-four hour period and the total quantity of byproduct material released into the sanitary sewerage system by the general licensee does not exceed 100 millicuries in any one year.

(5) He shall not transfer such pharmaceutical to another person except in the unopened, labeled shipping container as received from the supplier.

(6) He shall store the pharmaceutical until administered, in the original shipping container or a container providing equivalent radiation protection.

(7) He shall not use the pharmaceutical for any purpose other than medical diagnosis or therapy.

(8) He shall maintain, at each facility where the byproduct material is used, a calibrated and operable radiation survey instrument capable of measuring from 0.1 millirad per hour to 20 millirads per hour of the radiations emitted by the material generally licensed pursuant to paragraph (a) of this section.

(9) He shall calibrate or have calibrated each survey instrument at intervals not to exceed six (6) months and after each servicing.

(10) He shall secure byproduct material against unauthorized removal from the place of storage.

(11) He shall survey the immediate areas in which iodine 131 or phosphorus 32 is used for possible contamination immediately following a spill or unaccounted loss of any quantity of iodine 131 or phosphorus 32 and shall decontaminate such areas to a level not exceeding 2 millirads per hour measured at a distance of one centimeter from the surface.

(12) He shall maintain records showing the dates of calibration of each survey instrument, names of persons who performed the calibrations, and the results of surveys required by subparagraph (11) of this paragraph.

(13) He shall assure that each container in which a quantity of more than 10 microcuries of iodine 131 of phosphorus 32 is transported, stored, or used bears a durable, clearly visible label bearing the conventional three-bladed radiation symbol (magenta or purple on yellow background) and the words: "Caution—Radioactive Material." If the container is used for storage the label shall also state the quantities and kinds of radioactive materials in the container and the date of measurement of the quantities.

(14) He shall assure that each area or room in which a total of more than 100 microcuries of iodine 131 or phosphorus 32 is used or stored, excluding byproduct material contained in patients, is conspicuously posted with a sign bearing the conventional three-bladed radiation symbol and the words: "Caution—Radioactive Material(s)." Such posting is not required for an area or room which is under the licensee's control, and which contains byproduct material for less than eight hours, if the materials are constantly attended by an individual who will take necessary precautions to minimize exposure of individuals to the radiation.

(15) He shall comply with such radiation safety instructions which accompany the shipment of byproduct material and are referenced in the label attached to the container of the byproduct material.

(16) He shall report by telephone or telegraph to the Director, Division of Licensing and Regulation, Atomic Energy Commission within 24 hours after its occurrence becomes known to the licensee any loss or theft of more than one millicurie of iodine 131 or phosphorus 32.

(d) In addition to the conditions, limitations and requirements of paragraphs (b), (c), and (d) of this section, the general license provided in paragraph (a) of this section is subject to the conditions, limitations and requirements of §§ 30.32, 30.33, 30.41, 30.42, 30.43, 30.44, 30.52, and 30.61 of this part.

(e) The general licensee under paragraph (a) of this section is exempt from the requirements of Part 20 of this chapter with respect to the byproduct materials covered by the general license.

3. A new § 30.28 is added to read as follows:

§ 30.28 General license, cobalt 60 for interstitial, intracavitary therapy.

(a) A general license is hereby issued to any physician who has at least three years of experience in the interstitial or intracavitary use of sealed sources containing radioactive materials, and certifies to the Commission that he is familiar with the hazards and appropriate precautions associated with such sealed sources, to receive, possess, use, or transfer, in accordance with the provisions of paragraphs (b), (c), and (d) of this section, cobalt 60 contained in needles or tubes designed and manufactured for interstitial or intracavitary therapy.

(b) No physician shall receive, possess, use, or transfer byproduct material pursuant to the general license established by paragraph (a) of this section until he has:

(1) Filed Form AEC-482-A, "Registration Certificate—Generally Licensed Medical Devices," in triplicate with the Director, Division of Licensing and Regulation, U.S. Atomic Energy Commission, Washington 25, D.C., and

(2) Received from the Commission a validated copy of the Form AEC-482-A with registration number assigned.

(c) A physician who receives byproduct material pursuant to the general license established by paragraph (a) of this section shall comply with the following requirements:

(1) He shall not possess at any one time, pursuant to the general license in paragraph (a) of this section more than 100 millicuries of cobalt 60.

(2) He shall not receive, possess, or use byproduct material pursuant to the general license in paragraph (a) of this section, unless the container bears a label which includes the following statement: "This device may be distributed to physicians pursuant to general license 10 CFR 30.28 of the U.S. Atomic Energy Commission."

(3) He shall have the cobalt 60 needles and tubes tested for leakage of radioactive material by a person specifically licensed by the Commission to perform such tests, at no longer than twelve-month intervals by a test capable of detecting the presence of 0.005 microcurie of removable contamination on each sealed source. Any test which reveals the presence of 0.005 microcurie or more removable radioactive material shall be considered evidence that the sealed source is leaking.

(4) He shall immediately withdraw from use any cobalt 60 needle or tube which is leaking or has been damaged or broken and shall cause it to be repaired by the supplier or other person holding a specific license issued by the Commission to manufacture or repair such needle or tube, or dispose of it by transfer to a person specifically licensed by the Commission to receive the byproduct material. A report shall be filed in duplicate by the physician within 10 days after determining that any needle or tube is leaking, with the Director, Division of Licensing and Regulation, U.S. Atomic Energy Commission, Washington 25, D.C., describing the type of needle or tube involved, the test results, and the corrective action taken.

(5) He shall not transfer, abandon, or dispose of the needle or tube except by transfer to a person authorized to receive the byproduct material pursuant to a specific license issued by the Commission or pursuant to the general license in paragraph (a) of this section.

(6) He shall store the byproduct material, except when in use, in the shielded storage box or case in which it is received or in a container providing equivalent radiation protection.

(7) He shall secure each cobalt 60 needle or tube against unauthorized removal from its place of storage.

(8) He shall maintain, at each facility where the byproduct material is used, a calibrated and operable radiation survey instrument capable of measuring from 0.1 millirad per hour to 500 millirads per hour of the radiations emitted by the generally licensed material.

(9) He shall calibrate or have calibrated each survey instrument at intervals not to exceed six (6) months and after each servicing.

(10) He shall conduct after each use a physical inventory of the cobalt 60 needles or tubes to account for all the byproduct material used.

(11) He shall hospitalize any patient in whom the physician has inserted cobalt 60 until such time as the cobalt 60 is removed from the patient.

(12) He shall complete and attach a radioisotope record card to the bed or to the door of the room in which a patient with cobalt 60 in his body is hospitalized. The card shall accompany the patient whenever he leaves such room and shall include the following:

(i) The conventional three-bladed radiation caution symbol.

(ii) The name of the patient.

(iii) The number of millicuries of cobalt 60 which have been administered to the patient.

(iv) The name of the physician in charge.

(13) He shall post each area or room in which a cobalt 60 needle is being used or stored with a sign bearing the conventional three-bladed radiation symbol (magenta or purple on yellow background) and the words: "Caution—Radioactive material(s)."

(i) Such posting is not required for an area or room which is under the licensee's control and which contains cobalt 60 needles or tubes for less than eight hours if the cobalt 60 is constantly attended by an individual who will take necessary precautions to minimize exposure of individuals to the radiation.

(ii) Such posting is not required for a room or other area in a hospital because of the presence of cobalt 60 needles or tubes in patients provided there are personnel in attendance who will take necessary precautions to minimize the exposure of other persons to the radiation.

(14) He shall not possess, use or transfer generally licensed byproduct material in such a manner as to cause any individual, other than a patient to whom the byproduct material is administered, to receive in any period of one calendar quarter from generally licensed byproduct material and other sources of radiation in the licensee's possession a dose in excess of the limits specified in the following table:

	Rems Per Calendar Quarter
(i) Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	1¼
(ii) Hands and forearms; feet and ankles	18¾
(iii) Skin of whole body	7½

(15) He shall supply a film badge, pocket chamber, or pocket dosimeter to, and shall require the use of such personnel monitoring equipment by, any individual who is likely to receive a radiation dose in any one calendar quarter in excess of 25 percent of the applicable values specified in subparagraph (14) of this paragraph.

(16) He shall make or cause to be made such radiation surveys as may be necessary for him to comply with the provisions of this section.

(17) He shall report by telephone or telegraph to the Director, Division of Licensing and Regulation, immediately after its occurrence becomes known to the physician, any loss or theft of a cobalt 60 needle or tube.

(18) He shall maintain records of:

(i) All tests performed on the cobalt 60 needle or tube as required under this section, including dates and results of the tests and names of individuals who conduct the tests.

(ii) Dates of calibration for each survey instrument and names of persons who performed the calibrations.

(iii) Inventories of cobalt 60 needles or tubes.

(iv) The radiation dose of all individuals for whom personnel monitoring is required by subparagraph (15) of this paragraph.

(v) Radiation surveys required by § 30.28(c)(16).

(19) He shall comply with such radiation safety instructions which accompany the shipment of byproduct material and are referenced in the label attached to the container of the byproduct material.

(d) The general license provided in paragraph (a) of this section is subject to the provisions of §§ 30.32, 30.33, 30.41, 30.42, 30.43, 30.44, 30.52 and 30.61 of this part.

(e) The general licensee under paragraph (a) of this section is exempt from the requirements of Part 20 of this chapter with respect to the byproduct materials covered by the general license.

§ 30.24 [Amendment]

4. A new paragraph (k) is added to § 30.24 to read as follows:

(k) *Manufacture and distribution of byproduct material for exempt or generally licensed medical use.* An application for a specific license to manufacture, import, label, package, and distribute byproduct material for use by physicians exempt from licensing under § 30.11 or generally licensed under § 30.26 will not be approved unless:

(1) The applicant satisfies the general requirements specified in § 30.23.

(2) The applicant submits evidence that the byproduct material is to be manufactured, labeled, and packaged in accordance with a new drug application which the Commissioner of Food and Drugs, Food and Drug Administration, has permitted to become effective, or in accordance with a license issued by the Secretary, Department of Health, Education and Welfare.

(3) The applicant submits complete information as to the labeling to be affixed to the container of the byproduct material which shall bear one of the following statements, as appropriate:

(i) "This pharmaceutical may be distributed to physicians under license exemption of the U.S. Atomic Energy Commission."

(ii) "This pharmaceutical may be distributed to physicians pursuant to general license 10 CFR 30.26 of the U.S. Atomic Energy Commission."

(4) The labels and brochures which accompany each package of byproduct material:

(i) Contain adequate information as to precautions to be observed in handling and storing such byproduct materials;

(ii) Include a copy of § 30.11 or § 30.26 as appropriate.

5. A new paragraph (l) is added to § 30.24 to read as follows:

(l) *Manufacture of cobalt 60 needles or tubes for distribution to persons generally licensed under § 30.28* An application for a specific license to manufacture, import, label, package and distribute cobalt 60 needles or tubes for use by physicians generally licensed under § 30.28 will not be approved unless:

(1) The applicant satisfies the general requirements specified in § 30.23.

(2) The applicant submits sufficient information relating to the design, manufacture, prototype testing and quality control procedures for the cobalt 60 needles or tubes, to provide reasonable assurance that the byproduct material contained in the needle or tube under normal conditions of use will not be likely to escape therefrom.

(3) The applicant submits sufficient information relating to the storage container for the cobalt 60 needles or tubes, to provide reasonable assurance that:

(i) No person would be likely to receive a radiation exposure to a major portion of his body in excess of 0.5 rem in a year under ordinary circumstances of storage.

(ii) The storage container may be kept locked.

(4) The applicant submits complete information as to the labeling to be affixed to the storage container for the cobalt 60 needles or tubes, which shall contain adequate information for the safe use or manipulation of the cobalt 60 needle or tube and shall bear the following statement: "This device may be distributed to physicians pursuant to general license 10 CFR 30.28 of the U.S. Atomic Energy Commission."

(5) In describing the label or labels to be affixed to the storage container for the cobalt 60 needles or tubes, the applicant shall separately indicate those instructions and precautions which are necessary to assure safe use of the byproduct material.

(6) Cobalt 60 needles or tubes will be comprised of cobalt 60 wire hermetically sealed within stainless steel tubing, or within other metal or alloy having equivalent properties of resistance to corrosion and abrasion.

(7) Each cobalt 60 needle or tube will:

(i) Be subjected to suitable tests to detect possible leakage of byproduct material.

(ii) Be individually calibrated.

(iii) Have engraved upon it a code marking which indicates the linear intensity and number of millicuries for such needle or tube.

§ 30.32 [Amendment]

6. A new paragraph (g) is added to § 30.32 to read as follows:

(g) Each licensee authorized under § 30.24(l) to manufacture, import, label, package, and distribute cobalt 60 needles or tubes to generally licensed physicians:

(1) Shall report in duplicate to the Director, Division of Licensing and Regulation, all transfers of such cobalt 60 needles or tubes to physicians generally licensed under § 30.28(a). Such report shall identify each general licensee by name and address and registration number; date of transfer; the type of cobalt 60 needles or tubes transferred and the amount in millicuries of byproduct material contained in the needles or tubes. The report shall be submitted within 10 days after the end of each calendar month in which such needle or tube is transferred to a generally licensed physician.

(2) Shall furnish to each general licensee to whom he transfers such cobalt 60 needle or tube,

(i) A copy of the general license established by § 30.28.

(ii) A certificate of calibration which shall include a statement that the needle or tube has been tested and shows no detectable leakage of radioactive material to the exterior of the needle or tube, a statement of the dosage rate, and the name of the manufacturer."

Dated at Germantown, Md., this 10th day of January 1962.

For the Atomic Energy Commission.

WOODFORD B. MCCOOL,
Secretary.

[F.R. Doc. 62-517; Filed, Jan. 17, 1962; 8:45 a.m.]

(Reprinted in 27 Federal Register, 1373, February 14, 1962)

AGREEMENT BETWEEN THE UNITED STATES ATOMIC ENERGY COMMISSION AND THE COMMONWEALTH OF KENTUCKY FOR DISCONTINUANCE OF CERTAIN COMMISSION REGULATORY AUTHORITY AND RESPONSIBILITY WITHIN THE COMMONWEALTH

Whereas, The United States Atomic Energy Commission (hereinafter referred to as the Commission) is authorized under section 274 of the Atomic Energy Act of 1954, as amended (hereinafter referred to as the Act), to enter into agreements with the Governor of any State providing for discontinuance of the regulatory authority of the Commission within the State under Chapters 6, 7, and 8, and section 161 of the Act with respect to byproduct materials, source materials, and special nuclear materials in quantities not sufficient to form a critical mass, and;

Whereas, The Governor of the Commonwealth of Kentucky is authorized under section 152.115 of the Kentucky Revised Statutes to enter into this Agreement with the Commission; and

Whereas, The Governor of the Commonwealth of Kentucky certified on January 31, 1962, that the Commonwealth of Kentucky (hereinafter referred to as the Commonwealth) has a program for the control of radiation hazards adequate to protect the public health and safety with respect to the materials within the Commonwealth covered by this Agreement, and that the Commonwealth desires to assume regulatory responsibility for such materials, and;

Whereas, The Commission found on February 1, 1962, that the program of the Commonwealth for the regulation of the materials covered by this Agreement is compatible with the Commission's program for the regulation of such materials and is adequate to protect the public health and safety; and

Whereas, The Commonwealth recognizes the desirability and importance of maintaining continuing compatibility between its program and the program of the Commission for the control of radiation hazards in the interest of public health and safety; and

Whereas, The Commission and the Commonwealth recognize the desirability of reciprocal recognition of licenses and exemption from licensing of those materials subject to this Agreement; and

Whereas, This Agreement is entered into and is subject to the provisions of the Atomic Energy Act of 1954, as amended, and the applicable regulations of the Atomic Energy Commission which may be issued from time to time pursuant thereto;

Now, therefore, it is hereby agreed between the Commission and the Governor of the Commonwealth, acting in behalf of the Commonwealth, as follows:

ARTICLE I

Subject to the exceptions provided in Articles II, III, and IV, the Commission shall discontinue, as of the effective date of this Agreement, the regulatory authority of the Commission in the Commonwealth under Chapters 6, 7, and 8, and section 161 of the Act with respect to the following materials:

A. Byproduct materials;

B. Source materials; and

C. Special nuclear materials in quantities not sufficient to form a critical mass.

ARTICLE II

This Agreement does not provide for discontinuance of any authority and the Commission shall retain authority and responsibility with respect to regulation of:

A. The construction and operation of any production or utilization facility;

B. The export from or import into the United States of byproduct, source, or special nuclear material, or of any production or utilization facility;

C. The disposal into the ocean or sea of byproduct, source, or special nuclear waste materials as defined in regulations or orders of the Commission;

D. The disposal of such other byproduct, source, or special nuclear material as the Commission from time to time determines by regulation or order should, because of the hazards or potential hazards thereof, not be so disposed of without a license from the Commission.

ARTICLE III

Notwithstanding this Agreement, the Commission may from time to time by rule, regulation, or order, require that the manufacturer, processor, or producer of any equipment, device, commodity, or other product containing source, byproduct, or special nuclear material shall not transfer possession or control of such product except pursuant to a license or an exemption from licensing issued by the Commission.

ARTICLE IV

This Agreement shall not affect the authority of the Commission under subsection 161 b or i of the Act to issue rules, regulations, or orders to protect the common defense and security, to protect restricted data or to guard against the loss or diversion of special nuclear material.

ARTICLE V

The Commonwealth will use its best efforts to maintain continuing compatibility between its program and the program of the Commission for the regulation of like materials. To this end the Commonwealth will use its best efforts to keep the Commission informed of proposed changes in its rules and regulations, and licensing, inspection, and enforcement policies and criteria, and of proposed requirements for the design and distribution of products containing source, byproduct, or special nuclear material, and to obtain the comments and assistance of the Commission thereon.

ARTICLE VI

The Commission will use its best efforts to keep the Commonwealth informed of proposed changes in its rules and regulations, and licensing, inspection, and enforcement policies and criteria and to obtain the comments and assistance of the Commonwealth thereon.

ARTICLE VII

The Commission and the Commonwealth agree that it is desirable to provide for reciprocal recognition of licenses for the materials listed in Article I licensed by the other party or by any agreement State. Accordingly, the Commission and the Commonwealth agree to use their best efforts to develop appropriate rules, regulations, and procedures by which such reciprocity will be accorded.

ARTICLE VIII

The Commission, upon its own initiative after reasonable notice and opportunity for hearing to the Commonwealth, or upon request of the Governor of the Commonwealth, may terminate or suspend this Agreement and reassert the licensing and regulatory authority vested in it under the Act if the Commission finds that such termination of suspension is required to protect the public health and safety.

ARTICLE IX

This Agreement shall become effective on March 26, 1962, and shall remain in effect unless, and until such time as it is terminated pursuant to Article VIII.

Done at Washington, District of Columbia, in duplicate, this eighth day of February, 1962.

For the United States Atomic Energy Commission.

GLENN T. SEABORG,
Chairman.

For the Commonwealth of Kentucky.

BERT COMBS,
Governor.

[F.R. Doc. 62-1499; Filed, Feb. 13, 1962; 8:50 a.m.]

(Reprinted in 27 Federal Register, 1351, February 14, 1962)

Title 10—ATOMIC ENERGY

Chapter I—Atomic Energy Commission

PART 150—EXEMPTIONS AND CONTINUED REGULATORY AUTHORITY IN AGREEMENT STATES UNDER SECTION 274

Public Law 86-373, dated September 23, 1959, amended the Atomic Energy Act of 1954 by the addition of a new section 274, "Cooperation With States." One purpose of that legislation was to recognize the interests of the States in the peaceful uses of atomic energy and to clarify the respective responsibilities under the Atomic Energy Act of the Commission and the States with respect to the regulation of byproduct, source, and special nuclear materials.

Under section 274b. of the Atomic Energy Act, the Commission is authorized to enter into an agreement with the Governor of any State providing for discontinuance of the regulatory authority of the Commission under Chapters 6, 7, and 8, and section 161 of the Act with respect to the following materials within the State: Byproduct materials, source materials, and special nuclear materials in quantities not sufficient to form a critical mass.

Subsection (c) of section 274 of the Atomic Energy Act specifically excludes from such agreements the discontinuance of any Commission authority with respect to:

1. The construction and operation of any production or utilization facility;
2. The export from or import into the United States of any byproduct, source, or special nuclear material or of any production or utilization facility;
3. The disposal into the ocean or sea of byproduct, source, or special nuclear waste materials as defined in regulations or orders of the Commission;
4. The disposal of such other byproduct, source, or special nuclear material as the Commission determines by regulation or order should, because of the hazards or potential hazards thereof, not be so disposed of without a license from the Commission.

In addition to the foregoing the Commission, notwithstanding any agreement between the Commission and any State pursuant to subsection 274b. of the Act, is authorized by rule, regulation, or order to require that the manufacturer, processor or producer of any equipment, device, commodity or other product containing source, byproduct or special nuclear material shall not transfer possession or control of such product except pursuant to a license issued by the Commission.

On September 29, 1961, the Commission published for public comment a draft of a proposed 10 CFR Part 150, which would relinquish certain licensing authority to agreement States and exempt persons in those States from Commission licensing requirements. The Statement of Considerations published with the proposed Part 150 stated that the Commission had not taken a position as to whether it should retain or relinquish to the States its authority to regulate the commercial disposal by burial of atomic wastes, or its authority to license the distribution by producers of products containing atomic energy materials; and specifically invited public comment on those questions and on possible alternatives.

Following publication, comments were received from some fifty organizations and individuals. The proposed Part 150 was discussed with a number of committees representing national organizations, as well as with the Commission's Advisory Committee of State Officials. The majority of all comments received were concerned in the main with the question of whether the Commission should continue control in agreement States of the commercial land burial of byproduct, source, or special nuclear wastes and the question of whether the Commission should continue control of transfer by manufacturers, processors or producers of equipment, devices, commodities, or other products containing agreement materials.

The Commission has taken into consideration the comments and advice it has received in adopting the regulation set out herein. The Commission has decided against blanket reservations of control over land burial of waste and over the transfer of manufactured products.

However, as to land burial, the Commission finds, pursuant to section 274 c.(4), of the Act that because of the hazards or potential hazards thereof, high level atomic energy wastes from the chemical processing of irradiated fuel elements should not be disposed of without a license from the Commission This finding is reflected in § 150.15(a)(4). Control over the handling and storage of waste at the site of a reactor, including effluent discharge, will be retained by the Commission as a part of the control of reactor operation. The states will have control over land burial of low level wastes.

With respect to whether the Commission should retain or relinquish authority to license the transfer by manufacturers, processors or producers of equipment, devices, commodities or other products containing atomic energy materials, Part 150 provides for State regulatory control in this area except those items intended for use by the general public (§ 150.15(a)(6)). Thus, control over the manufacture and transfer of industrial type devices, such as thickness gauges, would be exercised by the agreement States.

Control over consumer type devices, such as luminous watches, would be retained by the Commission. The uncontrolled distribution of atomic materials in products designed for distribution to the general public, such as consumer type devices, and the ultimate uncontrolled release of these materials into the environment, involve questions of national policy which have not yet been resolved. It is for this reason that the Commission is retaining control over such products. The Commission recognizes that the phrase "products designed for distribution to the general public" is not precise. The purpose of the provision, however, will be discussed with each agreement State; serious difficulties in interpretation of the phrase are not anticipated.

In order to achieve the maximum degree of uniformity of design and labeling requirements for those products and devices which will be under State control, the agreement to be executed between the Commission and an agreement State will provide for cooperative arrangements under which the State will keep the Commission informed of

proposed requirements for the design and distribution of such products. In addition, the State will agree to use its best efforts to maintain its total control program compatible with the control program of the Commission on a continuing basis.

The agreement will also provide that the Commission and the agreement State will use their best efforts to develop rules, regulations and procedures by which reciprocal recognition of licenses covering agreement materials will be accorded.

In the implementation of the reciprocal recognition provision in the agreement, § 150.20 grants a general license to any person who holds a valid specific license from an agreement State to conduct the same activity in a non-agreement State, provided that the specific license does not limit the activity authorized by the license to specific installations or locations. The general license so provided in § 150.20 requires the licensee to comply with the appropriate provisions of Parts 20, 30, 31, 40, and 70 of Title 10. In addition, such licensee must register in advance with the Commission; must not in any non-agreement State, transfer or dispose of the radioactive material possessed or used under the general license except by transfer to a person specifically licensed by the Commission to receive such material; must not in any non-agreement State, possess or use radioactive material, or engage in the activity authorized in § 150.20 for more than 20 days in any period of 12 consecutive months, without obtaining a specific license from the Commission, and must comply with all terms and conditions of the specific State license except those terms and conditions as are contrary to the requirements of § 150.20.

There are certain classes of devices containing byproduct material which may be used under general licensing provisions contained in Part 30, § 30.21(c), if the device is manufactured in accordance with a specific license issued to the manufacturer by the Commission. Part 30 is being amended to provide that such products, if manufactured in an agreement State pursuant to a specific license from the agreement State, may be transferred to users in non-agreement States and used by the users under the general licensing provisions of Part 30.

The Commission's decision not to exercise its authority to license the transfer of products containing atomic energy materials (other than products designed for distribution to the general public) is based on the assumption that agreement States will maintain continuing compatibility between their programs and Commission programs; and that procedures will be devised assuring reasonable, reciprocal recognition of licenses and licensing requirements among such States and the Commission. If attainment of these objectives should prove to be unfeasible, the Commission will reconsider the need for the exercise of its authority to prescribe the specifications for products containing atomic energy materials.

It will be desirable for the Commission and agreement States to develop programs for the collection and exchange of data concerning the effectiveness of standards and procedures observed in their respective programs for licensing and regulating the possession and use of atomic energy materials. For this purpose, the Commission plans, in cooperation with the agreement States, to develop procedures under which the agreement States will furnish to the Commission such information as may be agreed upon from time to time; and the Commission will make available to each agreement State, summaries of the information received from other agreement States and from Commission licensees.

As has previously been announced, the Commission is conducting studies of activities involving the processing and use of very substantial quantities of byproduct material (in the order of hundreds of thousands of curies). These studies have been undertaken in part to provide information on which the Commission may make a determination as to whether provisions of the Price-Anderson Indemnity Act (section 170 of the Atomic Energy Act of 1954) should be extended to such activities. They have also been undertaken for the purpose of providing information as to whether the Commission should determine that facilities which process such quantities of byproduct material are production or utilization facilities within the meaning of Section 11 of the Act. If the Commission finds that such facilities should be classified as utilization facilities, the Commission's licensing and regulatory requirements would be applicable. The provisions of the Price-Anderson Indemnity Act cannot be made applicable except to activities licensed by the Commission.

The exemptions herein granted are issued in order to carry out agreements between the Commission and the Governor of any State under section 274b. of the Atomic Energy Act of 1954, as amended.

Pursuant to the Atomic Energy Act of 1954, as amended, and the Administrative Procedure Act of 1946, the following regulation is published as a document subject to codification, to be effective on publication in the FEDERAL REGISTER.

GENERAL PROVISIONS

AUTHORITY: §§ 150.1 to 150.30 issued under secs. 161 and 274, 68 Stat. 948; and 73 Stat. 688, 42 U.S.C. 2201 and 42 U.S.C. 2021.

GENERAL PROVISIONS

§ 150.1 Purpose.

The regulations in this part provide certain exemptions to persons in agreement States from the licensing requirements contained in Chapters 6, 7, and 8 of the Act and from the regulations of the Commission imposing requirements upon persons who receive, possess, use or transfer byproduct material, source, or special nuclear material in quantities not sufficient to form a critical mass; and to define activities in agreement States over which the regulatory authority of the Commission continues. The provisions of the Act, and regulations of the Commission apply to all persons in agreement States engaging in activities over which the regulatory authority of the Commission continues.

§ 150.2 Scope.

The regulations in this part apply to all States that have entered into agreements with the Commission pursuant to subsection 274b of the Act.

§ 150.3 Definitions.

As used in this part:

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

(b) "Agreement State" means any State with which the Commission has entered into an effective agreement under subsection 274b of the Act;

(c) "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;

(d) "Commission" means the Atomic Energy Commission or its duly authorized representatives;

(e) "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.

(f) "Person" means (1) any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, agency, any State or any political subdivision of any political entity within a State, and any legal successor, representative, agent, or agency of the foregoing other than Government agencies;

(g) "Production facility" means (1) any equipment or device determined by rule of the Commission to be capable of the production of special nuclear material in such quantity as to be of significance to the common defense and security, or in such manner as to affect the health and safety of the public; or (2) any important component part especially designed for such equipment or device as determined by the Commission;

(h) "Source material" means (1) uranium, thorium, or any other material which is determined by the Commission pursuant to the provisions of section 61 of the Act to be source mate-

rial; or (2) ores containing one or more of the foregoing materials, in such concentration as the Commission may by regulation determine from time to time;

(i) "Special nuclear material" means (1) plutonium, 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 (2) any material artificially enriched by any of the foregoing, but does not include source material;

(j) "State" means any State, Territory, or possession of the United States, the Canal Zone, Puerto Rico, and the District of Columbia;

(k) "Utilization facility" means (1) any equipment or device, except an atomic weapon, determined by rule of the Commission to be capable of making use of special nuclear material in such quantity as to be of significance to the common defense and security, or in such manner as to affect the health and safety of the public, or peculiarly adapted for making use of atomic energy in such quantity as to be of significance to the common defense and security, or in such manner as to affect the health and safety of the public; or (2) any important component part especially designed for such equipment or device as determined by the Commission.

§ 150.4 Communications.

All communications concerning the regulations of this part should be addressed to the United States Atomic Energy Commission, Washington 25, D.C., Attention: Division of Licensing and Regulation. Communications and reports may be delivered in person at the Commission's office at 1717 H Street NW., Washington, D.C., or its offices at Germantown, Maryland.

§ 150.5 Interpretations.

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

Exemptions in Agreement States

§ 150.10 Persons exempt.

Except as provided in § 150.15, any person in an agreement State who manufactures, produces, receives, possesses, uses or transfers byproduct material, source material, or special nuclear material in quantities not sufficient to form a critical mass is exempt from the requirements for a license contained in Chapters 6, 7, and 8 of the Act, regulations of the Commission imposing licensing requirements upon persons who manufacture, produce, receive, possess, use or transfer such materials, and from regulations of the Commission applicable to licensees. The exemptions in this section do not apply to agencies of the Federal government as defined in § 150.3.

§ 150.11 Critical mass.

(a) For the purposes of this part, special nuclear material in quantities not sufficient to form a critical mass means uranium enriched in the isotope U-235 in quantities not exceeding 350 grams of contained U-235; uranium-233 in quantities not exceeding 200 grams; plutonium in quantities not exceeding 200 grams; or any combination of them in accordance with the following formula: For each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified above for the same kind of special nuclear material. The sum of such ratios for all kinds of special nuclear materials in combination shall not exceed unity. For example, the following quantities in combination would not exceed the limitation and are within the formula, as follows:

$$\frac{175 \text{ (grams contained U-235)}}{350} + \frac{50 \text{ (grams U-233)}}{200} + \frac{50 \text{ (grams Pu)}}{200} = 1$$

(b) To determine whether the exemption granted in § 150.10 of this part applies, a person shall include in the quantity computed according to paragraph (a) of this section the total quantity of special nuclear material which he is authorized to receive, possess or use in a particular agreement State at any one time.

Continued Commission Regulatory Authority in Agreement States

§ 150.15 Persons not exempt.

(a) Persons in agreement States are not exempt from the Commission's licensing and regulatory requirements with respect to the following activities:

(1) The construction and operation of any production or utilization facility. As used in this subparagraph (1), "operation" of a facility includes, but is not limited to (i) the storage and handling of radioactive wastes at the facility site by the person licensed to operate the facility, and (ii) the discharge of radioactive effluents from the facility site.

(2) The export from or import into the United States of byproduct, source, or special nuclear material, or of any production or utilization facility.

(3) The disposal into the ocean or sea of byproduct, source, or special nuclear waste materials, as defined in regulations or orders of the Commission. For purposes of this part, ocean or sea means any part of the territorial waters of the United States and any part of the international waters.

(4) The transfer, storage or disposal of radioactive waste material resulting from the separation in a production facility of special nuclear material from irradiated nuclear reactor fuel. This subparagraph (4) does not apply to the transfer, storage or disposal of contaminated equipment.

(5) The disposal of such other byproduct, source, or special nuclear material as the Commission determines by regulation or order should, because of the hazards or potential hazards thereof, not be so disposed of without a license from the Commission.

(6) The transfer of possession or control by the manufacturer, processor, or producer of any equipment, device, commodity, or other product containing source, byproduct, or special nuclear material, intended for use by the general public.

(b) Notwithstanding any exemptions provided in this part, the Commission may from time to time by rule, regulation, or order, require that the manufacturer, processor, or producer of any equipment, device, commodity, or other product containing source, byproduct, or special nuclear material shall not transfer possession or control of such product except pursuant to a license or an exemption from licensing issued by the Commission.

Reciprocity

§ 150.20 Recognition of State licenses.[1]

(a) Subject to the provisions of paragraph (b) of this section, any person who possesses a specific license from an agreement State is hereby granted a general license to conduct the same activity in non-agreement States: *Provided,* That the specific license does not limit the activity authorized by the license to specified installations or locations.

(b) Notwithstanding any provision to the contrary in any specific license issued by an agreement State to a person who engages in activities in a non-agreement State under a general license provided in this section, the general license provided in this section is subject to the provisions of §§ 30.32, 30.41, 30.43, 30.44, 30.51, 30.52, and 30.61 of Part 30 of this chapter; §§ 40.41, 40.61 to 40.63, inclusive, 40.71 and 40.81 of Part 40 of this chapter; and §§ 70.32, 70.51 to 70.56 inclusive, 70.61, 70.62, and 70.71 of Part 70 of this chapter; and to the provisions of Part 20 and Part 31 of this chapter. In addition, any person who engages in activities in non-agreement States under a general license provided in this section:

(1) Shall file AEC Form No. 241 ("Report of Proposed Activities in Non-agreement States") in quadruplicate with the U.S. Atomic Energy Commission, Washington 25, D.C., Attention: Director, Division of Licensing and Regulation, prior to engaging in any such activity;

(2) Shall not in any non-agreement State transfer or dispose of radioactive material possessed or used under the

[1] Part 30 of this chapter is being amended to generally license the use and possession by persons in non-agreement States of certain devices containing byproduct material manufactured in an agreement State in accordance with the specifications in the specific license issued to the manufacturer by the agreement State.

general license provided in this section except by transfer to a person specifically licensed by the Commission to receive such material;

(3) Shall not possess or use radioactive material, or engage in the activities authorized in paragraph (a) of this section for more than 20 days in any period of 12 consecutive months;

(4) Shall comply with all terms and conditions of the specific license issued by an agreement State except such terms or conditions as are contrary to the requirements of this section.

ENFORCEMENT

§ 150.30 Violations.

An injunction or other court order may be obtained prohibiting any violation of any provision of the Act or any regulation or order issued thereunder. Any person who willfully violates any provisions 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.

Dated at Germantown, Md., this 7th day of February 1962.

For the Atomic Energy Commission.

WOODFORD B. MCCOOL,
Secretary.

[F.R. Doc. 62-1497; Filed, Feb. 13, 1962; 8:50 a.m.]

(Reprinted From 25 F. R., 12170, November 29, 1960)

TITLE 10—ATOMIC ENERGY

Chapter I—Atomic Energy Commission

PART 31—RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHIC OPERATIONS

On March 15, 1960, the Commission issued for public comment a new proposed regulation, 10 CFR Part 31, to establish radiation safety requirements for persons utilizing sealed sources of byproduct material for radiography. Comments filed by interested persons have been given careful consideration.

The regulation is designed to codify provisions which have been developed through experience and applied in the course of licensing radiography operations. It will minimize the need for routine inclusion in licenses of special provisions applicable to radiography and provides guidance as to information required in license applications.

The following rules are published as a document subject to codification, effective 90 days after publication in the FEDERAL REGISTER. The requirements of this regulation are in addition to, and not in substitution for, other requirements of the Atomic Energy Commission.

AUTHORITY: §§ 31.1 to 31.501 issued under sec. 161, 68 Stat. 948; 42 U.S.C. 2201.

GENERAL PROVISIONS

§ 31.1 Purpose.

The regulations in this part establish radiation safety requirements for persons utilizing sealed sources of byproduct material for radiography. The requirements of this part are in addition to, and not in substitution for, other requirements of this chapter.

§ 31.2 Scope.

The regulations in this part apply to all licensees who use byproduct material for radiography under a license issued by the Commission pursuant to the regulations in Part 30 of this chapter: *Provided, however,* That nothing in this part shall apply to uses of byproduct material for medical diagnosis or therapy.

§ 31.3 Definitions.

As used in this part:

(a) "Radiographer" means any individual who performs or who, in attendance at the site where the sealed source or sources are being used, personally supervises radiographic operations and who is responsible to the licensee for assuring compliance with the requirements of these regulations and the conditions of the license.

(b) "Radiographer's Assistant" means any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources or related handling tools, or survey instruments in radiography.

(c) "Radiographic Exposure Device" means any instrument containing a sealed source, fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded position for purposes of making a radiographic exposure.

(d) "Radiography" means the examination of the structure of materials by nondestructive methods utilizing sealed sources of byproduct material.

(e) "Sealed source" means any byproduct material that is encased in a capsule designed to prevent leakage or escape of the byproduct material.

(f) "Storage Container" means a device in which sealed sources are transported or stored.

(g) Other terms defined in section 11 of the Atomic Energy Act, as amended, shall have the same meaning when used in this part.

§ 31.4 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.

EQUIPMENT CONTROL

§ 31.101 Limits on levels of radiation for radiographic exposure devices and storage containers.

Radiographic exposure devices measuring less than four (4) inches from the sealed source storage position to any exterior surface of the device shall have no radiation level in excess of 50 milliroentgens per hour at six (6) inches from any exterior surface of the device. Radiographic exposure devices measuring a minimum of four (4) inches from the sealed source storage position to any exterior surface of the device, and all storage containers for sealed sources or for radiographic exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface, and ten (10) milliroentgens per hour at one meter from any exterior surface. The radiation levels specified are with the sealed source in the shielded (i.e., "off") position.

§ 31.102 Locking of radiographic exposure devices and storage containers.

Each radiographic exposure device shall be provided with a lock or outer locked container designed to prevent unauthorized or accidental removal or exposure of a sealed source and shall be kept locked at all times except when under the direct surveillance of a radiographer or radiographer's assistant, or as may be otherwise authorized pursuant to § 31.301. Each storage container likewise shall be provided with a lock and kept locked when containing sealed sources except when the container is under the direct surveillance of a radiographer or radiographer's assistant.

§ 31.103 Storage precautions.

Locked radiographic exposure devices and storage containers shall be physically secured to prevent tampering or removal by unauthorized personnel.

§ 31.104 Radiation survey instruments.

The licensee shall maintain sufficient calibrated and operable radiation survey instruments to make physical radiation surveys as required by this part and Part 20 of this chapter. Each radiation survey instrument shall be calibrated at intervals not to exceed three (3) months and after each instrument servicing and a record maintained of the latest date of calibration. Instrumentation required by this section shall have a range such that two milliroentgens per hour through one roentgen per hour can be measured.

§ 31.105 Leak testing, repair, tagging, opening, modification and replacement of sealed sources.

(a) The replacement of any sealed source fastened to or contained in a radiographic exposure device and leak testing, repair, tagging, opening or any other modification of any sealed source shall be performed only by persons specifically authorized by the Commission to do so.

(b) Each sealed source shall be tested for leakage at intervals not to exceed 6 months. In the absence of a certificate from a transferor that a test has been made within the 6 months prior to the transfer, the sealed source shall not be put into use until tested.

(c) The leak test shall be capable of detecting the presence of 0.005 microcuries of removable contamination on the sealed source. An acceptable leak test for sealed sources in the possession of a radiography licensee would be to test at the nearest accessible point to the sealed source storage position, or other appropriate measuring point, by a procedure to be approved pursuant to § 30.24 (g)(6) of this chapter. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Commission.

(d) Any test conducted pursuant to paragraphs (b) and (c) of this section which reveals the presence of 0.005 microcuries or more of removable radioactive material shall be considered evidence that the sealed source is leaking. The licensee shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed of, in accordance with Commission regulations. A report shall be filed, within 5 days of the test, with the Director, Division of Licensing and Regulation, U.S. Atomic Energy Commission, Washington 25, D.C., describing the equipment involved, the test results, and the corrective action taken. A copy of such report shall be sent to the Manager of the nearest Atomic Energy Commission Operations Office listed in Appendix D of Part 20 of this chapter "Standards For Protection Against Radiation."

(e) A sealed source which is not fastened to or contained in a radiographic exposure device shall have permanently attached to it a durable tag at least one (1) inch square bearing the prescribed radiation caution symbol in conventional colors, magenta or purple on a yellow background, and at least the instructions: "Danger—Radioactive Material—Do Not Handle—Notify Civil Authorities if Found."

§ 31.106 Quarterly inventory.

Each licensee shall conduct a quarterly physical inventory to account for all sealed sources received and possessed under his license. The records of the inventories shall be maintained for inspection by the Commission, and shall include the quantities and kinds of byproduct material, location of sealed sources, and the date of the inventory.

§ 31.107 Utilization logs.

Each licensee shall maintain current logs, which shall be kept available for inspection by the Commission at the address specified in the license, showing for each sealed source the following information:

(a) A description (or make and model number) of the radiographic exposure device or storage container in which the sealed source is located;

(b) The identity of the radiographer to whom assigned; and

(c) The plant or site where used and dates of use.

PERSONAL RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANTS

§ 31.201 Limitations.

(a) The licensee shall not permit any person to act as a radiographer as defined in this part until such person:

(1) Has been instructed in the subjects outlined in Appendix A of this part and shall have demonstrated understanding thereof;

(2) Has received copies of and instruction in the regulations contained in this part and the applicable sections of Part 20 of this chapter, AEC license(s), and the licensee's operating emergency procedures, and shall have demonstrated understanding thereof; and

(3) Has demonstrated competence to use the radiographic exposure devices, sealed sources, related handling tools and survey instruments which will be employed in his assignment.

(b) The licensee shall not permit any person to act as a radiographer's assistant as defined in this part until such person:

(1) Has received copies of and instructions in the licensee's operating and emergency procedures, and shall have demonstrated understanding thereof; and

(2) Has demonstrated competence to use under the personal supervision of the radiographer the radiographic exposure devices, sealed sources, related handling tools and radiation survey instruments which will be employed in his assignment.

§ 31.202 Operating and emergency procedures.

The licensee's operating and emergency procedures shall include instructions in at least the following:

(a) The handling and use of licensed sealed sources and radiographic exposure devices to be employed such that no person is likely to be exposed to radiation doses in excess of the limits established in Part 20 of this chapter "Standards For Protection Against Radiation;"

(b) Methods and occasions for conducting radiation surveys;

(c) Methods for controlling access to radiographic areas;

(d) Methods and occasions for locking and securing radiographic exposure devices, storage containers and sealed sources;

(e) Personnel monitoring and the use of personnel monitoring equipment;

(f) Transporting sealed sources to field locations, including packing of radiographic exposure devices and storage containers in the vehicles, posting of vehicles and control of the sealed sources during transportation;

(g) Minimizing exposure of persons in the event of an accident;

(h) The procedure for notifying proper persons in the event of an accident; and

(i) Maintenance of records.

§ 31.203 Personnel monitoring control.

(a) The licensee shall not permit any person to act as a radiographer or as a radiographer's assistant unless, at all times during radiographic operations, each such person shall wear a film badge and either a pocket dosimeter or pocket chamber. Pocket dosimeters and pocket chambers shall be capable of measuring doses from zero to at least 200 milliroentgens. A film badge shall be assigned to and worn by only one person.

(b) Pocket dosimeters and pocket chambers shall be read and doses recorded daily. A film badge shall be immediately processed if a pocket chamber or pocket dosimeter is discharged beyond its range. The film badge reports received from the film badge processor and records of pocket dosimeter and pocket chamber readings shall be maintained for inspection by the Commission.

PRECAUTIONARY PROCEDURES IN RADIOGRAPHIC OPERATIONS

§ 31.301 Security.

During each radiographic operation the radiographer or radiographer's assistant shall maintain a direct surveillance of the operation to protect against unauthorized entry into a high radiation area, as defined in Part 20 of this chapter, except (a) where the high radiation area is equipped with a control device or an alarm system as described in § 20.203(c)(2), or (b) where the high radiation area is locked to protect against unauthorized or accidental entry.

§ 31.302 Posting.

Notwithstanding any provisions in § 20.204(c) of this chapter, areas in which radiography is being performed shall be conspicuously posted as required by § 20.203 (b) and (c)(1) of this chapter.

§ 31.303 Radiation surveys and survey records.

(a) No radiographic operation shall be conducted unless calibrated and operable radiation survey instrumentation

as described in § 31.104 is available and used at each site where radiographic exposures are made.

(b) A physical radiation survey shall be made after each radiographic exposure during a radiographic operation to determine that the sealed source has been returned to its shielded condition.

(c) A physical radiation survey shall be made to determine that each sealed source is in its shielded condition prior to securing the radiographic exposure device and storage container as specified in § 31.102.

(d) Records shall be kept of the surveys required by paragraph (c) of this section and maintained for inspection by the Commission.

EXEMPTIONS AND ADDITIONAL REQUIREMENTS

§ 31.401 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.

§ 31.402 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

§ 31.501 Violations.

An injunction or other court order may be obtained prohibiting any violation of any provisions of the Act or any regulation or order issued thereunder. Any person who wilfully 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.

APPENDIX A

I. Fundamentals of radiation safety.
A. Characteristics of gamma radiation.
B. Units of radiation dose (mrem) and quantity of radioactivity (curie).
C. Hazards of excessive exposure of radiation.
D. Levels of radiation from licensed material.
E. Methods of controlling radiation dose.
1. Working time.
2. Working distances.
3. Shielding.
II. Radiation detection instrumentation to be used.
A. Use of radiation survey instruments.
1. Operation.
2. Calibration.
3. Limitations.
B. Survey techniques.
C. Use of personnel monitoring equipment.
1. Film badges.
2. Pocket dosimeters.
3. Pocket chambers.
III. Radiographic equipment to be used.
A. Remote handling equipment.
B. Radiographic exposure devices.
C. Storage containers.
IV. The requirements of pertinent Federal Regulations.
V. The licensee's written operating and emergency procedures.

Dated at Germantown, Maryland this 18th day of November 1960.

For the Atomic Energy Commission.

WOODFORD B. MCCOOL,
Secretary.

[F.R. Doc. 60-11013; Filed, Nov. 28, 1960; 8:45 a.m.]

Tracerlab inc.

LIMITED USE RADIOISOTOPE TRAINING COURSE

Certificate of Credit

This is to certify that

Paul Jonas

has attended and satisfactorily completed on March 17, 1957 the Limited Use Radioisotope Training Course offered by Tracerlab, Inc.

FOR INDUSTRIAL RADIOGRAPHY

A. DeHaan Jr.
Head, Technical Department

P. E. Underhill
Instructor

Tracerlab inc.

LIMITED USE RADIOISOTOPE TRAINING COURSE

Certificate of Credit

This is to certify that

Charles Kendrick

has attended and satisfactorily completed on March 17, 1957 the

Limited Use Radioisotope Training Course offered by Tracerlab, Inc.

FOR INDUSTRIAL RADIOGRAPHY

A. Ulthaar Jr.
Head, Technical Department

P. C. Underhill
Instructor

Radiation Health Physics Training Program

This is to certify that [illegible]

has successfully completed the Radiation Health Physics Program conducted by Nuclear Systems, a Division of The Budd Company.

This individual is considered by Nuclear Systems to be qualified in the safe handling of Gamma Emitting Isotopes.

The program meets the requirements and has the approval of the United States Atomic Energy Commission.

NUCLEAR SYSTEMS
A Division of The Budd Company

Dated August 27 *19* 59

Training Director

©GOES 463

LITHO IN U.S.A.