MASTER

ACNP-68505J

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LA CROSSE BOILING WATER REACTOR

OPERATING MANUAL

VOLUME X: HEALTH PHYSICS PROCEDURES

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PREFACE

The Operating Manual for the La Crosse Boiling Water Reactor is being published in 11 volumes. This is Volume X: Health Physics Procedures (ACNP-68505J). The volumes that comprise the Operating Manual are listed below.

Volume I:	Integrated Plant Operation	(ACNP-68505A)
Volume II:	Reactor Process Systems	(ACNP-68505B)
Volume III:	Turbine Generator Systems	(ACNP-68505C)
Volume IV:	Instrumentation, Control and Electrical Distribution	(ACNP-68505D)
Volume V:	Service System	(ACNP-68505E)
Volume VI:	Refueling	(ACNP-68505F)
Volume VII:	Waste Collection and Treatment	(ACNP-68505G)
Volume VIII:	Water Chemistry	(ACNP-68505H)
Volume IX:	Nuclear Materials Accountability Procedures	(ACNP-68505I)
Volume X:	Health Physics Procedures	(ACNP-68505J)
Volume XI:	Industrial Safety	(ACNP-68505K)

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HEALTH PHYSICS PROCEDURES

1. RESPONSIBILITIES

1.1 GENERAL

Safety is a line responsibility. This volume provides guides, limits, procedures, and recommendations to assist all personnel in carrying out their responsibilities for the economical and safe operation of the La Crosse Boiling Water Reactor (LACBWR) plant. Supplementary procedures covering specific operations will be issued as needed. Such supplements will be in the form of LACBWR Health and Safety Memoranda to this volume. This volume also provides procedures necessary to facilitate compliance with the Code of Federal Regulations, Title 10, Part 20, Standards for Protection Against Radiation, and the 0500 series, Health and Safety, Atomic Energy Commission Manual.

1.2 PLANT SUPERINTENDENT

The plant superintendent (Project Operations Manager) has complete responsibility for safe startup, operation, and maintenance of the plant. In discharging these responsibilities, he is assisted by the Health and Safety Engineer and by other operational supervisors.

1.3 HEALTH AND SAFETY ENGINEER

The Health and Safety Engineer is responsible to the Plant Superintendent for the planning and direction of the plant health and safety programs and for technical and functional supervision over the health physics technicians. His specific duties are:

- (1) Planning, recommending, scheduling, and directing all LACBWR health physics, industrial safety, industrial hygiene, and fire protection programs and activities.
- (2) Evaluating, interpreting, and recommending action on plant and local matters concerning health physics, industrial safety, industrial hygiene and fire protection.
- (3) Planning, recommending, and directing the functions performed by the chemical laboratory.
- (4) Recommending radiation exposure limits for plant personnel based on established regulations and policies.
- (5) Minimizing and controlling, within established limits, radiation exposure of all plant personnel.
- (6) Evaluating plant health and safety performance, and making recommendations regarding improvements and revisions.

(7) Enforcing strict compliance with all established safety and radiation protection rules and regulations; exercising his authority and responsibility for ordering hazardous work to cease until the shift supervisor and/or the plant superintendent are apprised of the situation.

(8) Maintaining complete, accurate, and legible records of personnel radiation exposure, radiological surveys, environmental monitoring, radiochemical analyses, radioactive waste disposal, personnel industrial hygiene, and of all other necessary plant health and safety activities.

(9) Preparing, revising, and maintaining health and safety procedures, training materials, laboratory procedures, reports, reviews, decontamination procedures, and other required health and safety written materials.

(10) Conducting a continuous training program for the health physics technicians to establish and maintain a high degree of proficiency; assisting in training other plant personnel on matters of health physics, industrial safety, and laboratory techniques.

(11) Performing liaison and coordination with local, state, and federal agencies concerning health physics and industrial safety activities.

(12) Ensuring that all applicable regulations and safety requirements are met when shipping radioactive materials.

(13) Planning, recommending, and directing the protective clothing program (including acquisition, storage, issuance, handling, cleaning, and disposal of such clothing).

(14) Assisting in the direction of any actions during emergencies.

1.4 SUPERVISORS

Supervisors are responsible for the safety of operations under their jurisdiction and for enforcing compliance by operating personnel and visitors with the rules and regulations set forth within this volume. Supervisors shall ensure that personnel under their supervision are informed about limits and procedures set forth in this volume.

Supervisors shall also take necessary action to correct hazardous conditions, prevent accidents, take necessary steps if an accident does occur, etc. This responsibility involves contacting the LACBWR Health and Safety Engineer or his representative when a supervisor feels that such action is necessary, or taking immediate action and reporting to LACBWR Health and Safety as soon as possible.

1.5 OPERATIONS GROUP PERSONNEL

Each member of the operations group shall observe the rules and procedures established by this volume. Each member shall report to the supervisor in charge, or to the LACBWR

Health and Safety Engineer or his representative, all situations in which a hazard appears to exist or where doubt exists as to the safety of an operation. All accidents, whether or not radiation or radioactivity are involved, shall be reported to the shift supervisor on duty, who will take any necessary immediate corrective action and who will also ensure that the Plant Superintendent and the Health and Safety Engineer are notified.

2. RADIATION PROTECTION GUIDES

2.1 BASIC PHILOSOPHY

The radiation exposure criteria set forth in this chapter are for the protection of personnel against radiation hazards arising from work associated with the operation of LACBWR. They require that no person under 18 years of age shall be occupationally exposed to ionizing radiation. A continuous effort should be made to reduce levels of radiation and radioactivity in order to maintain radiation doses at the lowest practical value below these established limits.

2.2 EXTERNAL RADIATION LIMITS

2.2.1 Lifetime

Accumulated total whole body, head, trunk, active blood-forming organs, lenses of the eyes, and gonads radiation exposure shall be limited to 5 (N-18) rem, where N is person's age in years.

2.2.2 Quarterly

Whole body, head, trunk, active blood-forming organs, lenses of the eyes, and gonads radiation exposure will be limited to 3 rem per calendar quarter. Previous occupational radiation exposure history for all plant personnel will be determined by execution of an AEC Form 4 or its equivalent.

Exposure to extremities (hands, forearms, feet, ankles) shall be limited to 18.75 rem per quarter. Exposure to skin of the whole body shall be limited to 7.5 rem per quarter.

2.2.3 Yearly

Administrative guides limit external radiation whole body exposure to 5 rem per calendar year, and every effort will be made to equalize exposures of all personnel to provide for compliance with this guide.

2.2.4 Daily

An operational limit of 300 mrem/day should not be exceeded without prior approval of the Health and Safety Engineer.

2.3 INTERNAL EXPOSURE LIMITS

Exposure to atmospheric contamination exceeding occupational Radiation Concentration Guides, (RCG's) in Table 1 of 10 CFR 20 (Appendix B) or AECM-0524, is permissible

provided the average concentration for the hours worked in any seven consecutive days does not exceed 40 RCG hours. Respiratory protection shall be worn in areas where the atmospheric contamination exceeds the occupational RCG's in Table 1 of 10 CFR 20 (Appendix B).

Suspected overexposure to airborne or waterborne concentrations of radioactive materials will be investigated by whole-body counting and/or urinalysis.

2.4 PERMISSIBLE LEVELS OF RADIATION AND CONCENTRATIONS IN EFFLUENTS TO UNRESTRICTED AREAS

Radiation levels shall be limited to the extent that any individual in an unrestricted area will not receive a dose to the whole body exceeding 0.5 rem per year. Concentrations in effluents shall be limited such that the exposure of individuals to concentrations of radioactive material in air and water averaged over a period not greater than one year does not exceed the limits specified in Table 2 of 10 CFR 20 (Appendix B) or AECM-0524.

2.5 PERMISSIBLE LEVELS OF CONTAMINATION

Personnel, material, and equipment released from restricted areas shall be free of significant radioactive contamination. Release surveys shall be performed with the most sensitive instruments available and shall include alpha, beta, and gamma radiation unless it is known that a given type is not present. Release surveys must be performed where the background does not exceed 500 c/m on beta-gamma detection meters, or 200 c/m on alpha detection meters. Any material or equipment that has smearable contamination in excess of 2000 d/m/ft² beta-gamma or 500 d/m/ft² alpha cannot be released as being free of contamination. For fixed contamination of personnel, their personal clothing, material or equipment, the following release limits shall apply except with the specific approval of the Health and Safety Engineer.

(1) Beta-gamma contamination: 200 c/m per GM probe area (or end window probe area if low energy radiations are present).

(2) Alpha contamination: 250 d/m per detector probe area.

2.6 EMERGENCY EXPOSURE GUIDES

In the event of an emergency, it may be desirable to allow short exposures in excess of those limits given in Secs. 2.2 and 2.3 to prevent serious bodily injury or property damage. When external gamma radiation is present, a total dose of 100 to 150 roentgens may be acceptable on a volunteer basis, but only if the successful saving of human life will result. If the saving of life is not involved, but if a reduction of human injury will result, a total

dose of 25 roentgens may be acceptable. If neither the saving of life nor the reduction of serious injury is involved, the total gamma dose shall be kept below 25 roentgens and, if possible, below 12 roentgens. In any case, the dose received should be kept to the minimum practicably attainable. All personnel receiving such exposures must be wearing personnel monitoring devices capable of measuring the radiation doses. To ensure their safety and to preclude legal questions concerning the actual doses received, persons not wearing monitoring equipment should be severely restricted with respect to the amount of radiation to which they are exposed.

3. RADIATION AREA POSTING REQUIREMENTS

3.1 DEFINITIONS

(1) Radiation Area: any area, accessible to personnel, in which radiation exists at such levels that a major portion of the body could receive, in any 1 hr, a dose in excess of 5 mrem or, in any five consecutive days, a dose of 100 mrem.

(2) High Radiation Area: any area, accessible to personnel, in which radiation exists at such levels that a major portion of the body could receive, in any 1 hr, a dose in excess of 100 mrem.

(3) Airborne Radioactivity Area: any area or room where airborne radioactive materials exist in concentrations exceeding those of Table 1, Column 1, of 10 CFR 20 (Appendix B), or where concentrations of airborne radioactivity exist which, averaged over the number of hours in a week during which individuals are in the area, exceed 25 percent of those in Table 1, Column 1, of 10 CFR 20 (Appendix B).

3.2 CAUTION SIGNS AND LABELS

(1) Radiation Areas: each radiation, high radiation, or airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the standard radiation caution symbol and the words:

CAUTION
RADIATION AREA

(or)

DANGER
HIGH RADIATION AREA

(or)

CAUTION
AIRBORNE RADIOACTIVITY AREA

(2) Radioactive Material Areas: each area or room in which radioactive material (other than natural uranium or thorium) is used or stored in any amount exceeding 10 times that given in 10 CFR 20 (Appendix B) or natural uranium or thorium in an amount exceeding 100 times those given in 10 CFR 20 (Appendix B) shall be conspicuously posted with a sign or signs bearing the standard radiation caution symbol and the words:

CAUTION
RADIOACTIVE MATERIALS

(3) Radioactive Material Containers: each container in which radioactive materials (other than natural uranium or thorium) is transported, stored, or used in quantities exceeding those given in 10 CFR 20 (Appendix B), or natural uranium or thorium in quantities exceeding 10 times those given in 10 CFR 20 (Appendix B) shall bear a durable, clearly visible label bearing the standard radiation caution symbol and the words:

CAUTION
RADIOACTIVE MATERIALS

(4) Contaminated Areas: areas exceeding surface contamination levels outlined in Sec. 2.5 shall be posted with a sign or signs bearing the standard radiation symbol and the words:

CAUTION
CONTAMINATED AREA

(5) Exemption From Posting: notwithstanding the provisions of 20.203 of 10 CFR 20:

(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 12 in. from the surface of the source container or housing does not exceed 5 mrem/hr.

(b) Caution signs are not required to be posted at areas or rooms containing radioactive materials for periods of less than 8 hr provided that:

(i) 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

(ii) such area or room is subject to the licensee's control.

(6) Storage of Radioactive Materials: radioactive materials stored in an unrestricted area shall be secured against unauthorized removal from the place of storage.

3.3 STANDARD RADIATION SYMBOL

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 magenta or purple.
- (2) Background is yellow.
- (3) Wording may employ black or magenta letters.

4. PERSONNEL DOSIMETRY

4.1 GENERAL CONSIDERATIONS

To ensure that the limits set forth in Sec. 2 are not exceeded, a personnel radiation exposure monitoring system is required.

Two basic devices shall be used to evaluate, for control purposes, each individual's radiation exposure:

(1) Film badges, to give integrated dose measurements over relatively long periods of time; and

(2) Self-reading dosimeters, to give interim indication of accumulated doses.

4.2 PERSONNEL DOSIMETERS

4.2.1 Film Badges

Film badges shall be worn by all operating personnel entering the plant. The film badge shall normally be worn at or above the waist and on the front part of the body, unless LACBWR Health and Safety recommends that the badge be worn differently. When leaving the site, personnel shall leave the badges on the racks provided for them. Film packs will be changed monthly or as near the first of the month as practical. Ring badges and/or waist badges are also available from the LACBWR Health and Safety for special monitoring applications. A central film badge rack is located in the hallway on the mezzanine floor of the plant. All operating personnel will pick up and replace their film badge and dosimeter at this rack when entering and leaving the building.

4.2.2 Self-Reading Dosimeters

Self-reading dosimeters as well as film badges will be worn by all plant personnel entering the plant. Health and Safety personnel will read the dosimeters daily and record the readings in a log provided for that purpose. Any employee may zero his own dosimeter, but he should record this fact in the log provided. Exposure estimate cards are available for employee use.

4.3 VISITORS' RADIATION EXPOSURE MONITORING

4.3.1 Long-Term Visitors

Long-term visitors, or those expecting to get significant radiation exposure, will be issued film badges and will be monitored in the same manner as the regular site personnel are monitored.

4.3.2 Casual and Short-Term Visitors

Casual and short-term visitors (those for whom exposures are expected to be insignificant) will be issued pocket dosimeters. The resultant radiation exposure indicated will be recorded in a log book maintained especially for that purpose.

4.4 SPECIAL USES OF FILM BADGES AND DOSIMETERS

Film badges and dosimeters may be used for special experimental purposes and for routine area monitoring. These badges will be distinctively marked and will be controlled by LACBWR Health and Safety.

4.5 BIOASSAY-RADIOURINALYSES

LACBWR Health and Safety is responsible for designating those individuals for whom radio-urinalysis is required. All new employees expected to be routinely working with radioactive material, and individuals suspected of having received an internal exposure in excess of the permissible exposure, shall be required to submit a urine specimen within 24 hr of exposure to determine the amount of internally-deposited radioactive materials. Each terminating employee who worked with radioactive materials will be required to submit a final urine specimen to determine the amount of internally-deposited radio-nuclides. Directions for collecting samples will be supplied by LACBWR Health and Safety. Samples will be sent to an outside contractor for analysis.

4.6 PERSONNEL EXPOSURE RECORDS

4.6.1 Responsibility

LACBWR Health and Safety will be responsible for recording and evaluating personnel radiation exposure information.

4.6.2 Records

Monthly film badge records received from the film badge processor will be evaluated and recorded. Also, running quarterly exposure totals will be kept.

Supporting information, bioassay results, extremity exposures, and investigations of exposures not recorded by film badges (lost film badge) will also be kept on file. (See Appendix A-1.)

4.6.3 Reports

Reports will be submitted as required by AEC Manual, Chapters 0502 and 0525. Upon written request, employees will be given an annual summary evaluation of their radiation

exposure.. In the event of any incident involving radiation exposure (besides routine reports to the AEC and to management), a report will also be given to the employee(s) involved.

5. RADIATION MONITORING INSTRUMENTATION

5.1 GENERAL INFORMATION

Radiation monitoring instrumentation for the LACBWR consists of fixed plant-surveillance equipment, portable survey meters, and laboratory-type counting instrumentation. The purpose and use of the fixed radiation monitors are described in ACNP-64634, Final Safeguards Reports for LACBWR. Calibration of all instrumentation will be accomplished prior to the initial startup of the reactor; the portable monitoring instrumentation will be recalibrated semi-annually or after it has undergone any major maintenance. Air and water effluent monitors will be recalibrated prior to each refueling shutdown. The equipment will be maintained as recommended by the equipment manufacturer, but routine preventive maintenance shall be scheduled annually. Alarm settings for the instrumentation will be determined during the testing program. For the effluent water monitors, alarms will be set so that an alarm will be given if radioactivity concentrations exceed the permissible concentrations. For the stack gaseous and particulate monitor, an alarm will be given if the activity in the effluent line is such that after release from the stack, the maximum ground concentration of activity (when averaged over one year) would be equal to the radioactivity concentration guide. For the containment building air exhaust gaseous and particulate monitor and the air ejector off-gas fission products monitor, the alarm is given if the maximum ground concentration (when averaged over one year) would be equal to ten times the radioactivity concentration guide. For the plant mobile particulate monitor, alarms are given if the activity concentration exceeds the radioactivity concentration guide.

5.2 PLANT SURVEILLANCE INSTRUMENTATION

5.2.1 Liquid Waste and Service Water, Auxiliary Component Cooling Water, and Turbine Condenser Cooling Water Monitors

The main components of each system consist of a Tracerlab Model MW-2P Liquid Sampler (Scintillation Type, Gamma), an MD-5B Gamma Scintillation Detector Assembly, and an RM-20B Transistor Precision Log Ratemeter mounted on the main control board.

5.2.2 Air Ejector Off-Gas Fission Products Monitor

The main components of this system include Gamma Scintillation Detector, Model MD-5B, and an RM-20B Transistor Precision Log Ratemeter mounted on the main control board.

5.2.3 Containment Building, Air Exhaust, Gaseous and Particulate Monitor and Stack Gaseous and Stack Particulate Monitors

The main components of these systems include Tracerlab Models MA-1B Filter Type Transport Mechanism, two MD-4B Beta Scintillation Detector Assemblies, MG-1A Gas Sampler

(Scintillation Type, Gamma), MD-5B Gamma Scintillation Detector Assembly, and an RM-20B Transistor Precision Log Ratemeter mounted on the main control panel.

5.2.4 Plant Mobile Particulate Monitor

This system is similar to the two systems in Sec. 5.2.3 except that no gaseous monitor is included. The ratemeters are mounted locally on the sampling unit.

5.2.5 Fixed Location Area Monitors

The fixed location area monitors comprise a 15-channel system which consists of 13 Tracerlab Model TA-6A10R Remote Detectors and two TA-6A100R Remote Detectors with power supply and remote meter alarms. These monitors are located as follows:

<u>unit number</u>	<u>range</u>	<u>location of detector</u>	<u>location of indicator</u>
1	0.01 mr/hr to 10 r/hr	west side of main airlock on containment building wall, el. 648 ft	at entrance to main airlock
2	0.01 mr/hr to 10 r/hr	containment building south wall, el. 707 ft	integral with detector
3	0.01 mr/hr to 10 r/hr	outside shield wall for primary system ion exchange	integral with detector
4	0.01 mr/hr to 10 r/hr	north shield wall, turbine building, el. 660 ft	integral with detector
5	0.01 mr/hr to 10 r/hr	southeast wall, containment building, near emergency airlock, el. 650 ft	integral with detector
6	0.01 mr/hr to 10 r/hr	southwest wall, containment building, el. 673 ft	integral with detector
7	0.1 mr/hr to 100 r/hr	near in-core flux monitoring units, el. 637 ft	northwest side reactor shield, el. 647 ft
8	0.1 mr/hr to 100 r/hr	shutdown condenser vent line	701-ft level
9	0.01 mr/hr to 10 r/hr	main work area, waste treatment building	integral with detector
10	0.01 mr/hr to 10 r/hr	basement area, waste treatment building	next to indicator No. 9

<u>unit number</u>	<u>range</u>	<u>location of detector</u>	<u>location of indicator</u>
11	0.01 mr/hr to 10 r/hr	north turbine shield wall, turbine building, el. 674 ft	integral with detector
12	0.01 mr/hr to 10 r/hr	control room south wall	integral with detector
13	0.01 mr/hr to 10 r/hr	east wall, turbine building, el. 648 ft	integral with detector
14	0.01 mr/hr to 10 r/hr	west wall, turbine building, el. 648 ft	integral with detector
15	0.01 mr/hr to 10 r/hr	pipng tunnel outside waste water storage tank area, el. 633 ft	head of stairs at south side feedwater pumps, turbine building

5.2.6 Portal Monitor

This is a Technical Associates Portal Monitor Model PPM-8. This monitor is located in the corridor between the change room and the laundry room.

5.3 PORTABLE SURVEY METERS

5.3.1 Alpha, Beta, Gamma Ionization Survey Meters

Three Technical Associates, Juno Survey Meters, Model SRJ-7, with full-scale ranges of 50, 500, and 5000 mr/hr are used.

5.3.2 Alpha, Beta, Gamma Ionization Survey Meters (High Level)

Two Technical Associates Ionization Chambers, to be used with Cutie Pie Survey Meters, Model CP-TP-1A, full-scale ranges: 50, 500, and 5000 r/hr. One Technical Associates, Juno Survey Meter, Model HRJ-7, with full-scale ranges of 250, 2500, and 25,000 mr/hr is used. Five Technical Associates, Cutie Pie Survey Meters, Model CP-4, full-scale ranges: 50, 500, and 5000 mr/hr. Three Technical Associates Cutie Pie Survey Meters, Model CP-TP-1A, full-scale ranges: 0.5, 5, and 50 r/hr.

5.3.3 Alpha, Beta, Gamma Thin-Window Geiger-Mueller Survey Meters

Two Victoreen Portable Survey Meters, Thyac II, Model 489-35, with full-scale ranges of 0.2, 2, and 20 mr/hr and six Victoreen Portable Survey Meters, Thyac III, Model 490, full-scale ranges: 800, 8000, and 80,000 cpm are used.

5.3.4 Alpha, Gas Flow, Proportional Survey Meter

Two Eberline, Portable Gas Proportional Alpha Counters, Model PAC-3G, with full-scale ranges of 1000, 10,000, and 100,000 counts/min are used.

5.3.5 Neutron Survey Meter

One Eberline Portable Fast, Slow Neutron Counter, Model PNC-1, with full-scale ranges of 500, 5000, 50,000, and 500,000 events/min is used.

5.3.6 Linear, Glass Wall, Geiger-Mueller Countrate Meter

Two Eberline Beta-Gamma Survey Meters, Model RM3A, with full-scale ranges of 500, 5000, and 50,000 counts/min are used.

5.3.7 Pocket Dosimeters

The following equipment is available and satisfies the pocket dosimetry requirements:

- (1) Twenty-five Tracerlab Pocket Dosimeters, Model K-112, for the detection of gamma radiation only; range: 0-200 mr.
- (2) Twenty-five Tracerlab Pocket Dosimeters, Model L-65, for the detection of gamma radiation only; range: 0-200 mr.
- (3) One Tracerlab Charger Reader, Model L-60.
- (4) One Tracerlab Charger, Model K-135-C.
- (5) Fifty Stephen Pocket Dosimeters, range: 0-200 mr.
- (6) Ten Stephen Pocket Dosimeters; range: 0-10 r.
- (7) Ten Stephen Pocket Dosimeters; range: 0-50 r.
- (8) Ten Stephen Pocket Dosimeters; range: 0-600 r.
- (9) One Stephen Charger.

5.4 LABORATORY-TYPE COUNTING INSTRUMENTS

5.4.1 Gas Flow Counting System

Three Nuclear Measurements Corporation Systems; each system includes one Model DS-IT Scaler and one Model PCC-II-T Gas Flow Counter and Shield.

5.4.2 GM Counting System

One Nuclear Measurements Corporation System which includes one Model DS-IT Scaler, one GM Detector, and one Model US-I Lead Shield.

5.4.3 Gamma Spectrometer

One nuclear-data multi-channel analyzer, Model 130-A is used.

5.5 INSTRUMENT CALIBRATION AND MAINTENANCE RECORDS

LACBWR Health and Safety will keep records of instrument calibration and maintenance to ensure that equipment is kept in adequate working condition. A log book shall be maintained showing the dates of calibration and maintenance of the health physics equipment, any pertinent repair work or recalibration, and the initials of the authorized health physics personnel or instrumentation engineer who performed the work.

6. RADIATION AND CONTAMINATION CONTROL

6.1 GENERAL MONITORING INFORMATION

6.1.1 Introduction

Personnel should be aware of the potential hazard involved before entering a potential radiation area or a potentially contaminated area. The sections of this chapter outline the procedures which will be used by LACBWR Health and Safety and by other plant personnel to ensure that the potential hazard is adequately defined, that adequate controls are instituted so that radiation exposure to personnel working in radiation areas or working with radioactive materials is minimized, and that each person carries out his work in a radiologically safe and economical manner.

6.1.2 External Dose-Rate Measurements

In addition to the measurements made by the fixed-location area radiation monitors, the measurement of external dose-rates is accomplished by portable survey instruments. The operation of the survey instruments shall be in accordance with the operating instructions outlined in each particular instrument manual. Instruments covering high, intermediate, and low ranges are available on the site, at the north and south evacuation assembly points, and at Dairyland Power Cooperative (DPC) Headquarters Building in La Crosse, Wisconsin.

6.1.3 Loose Surface Contamination Measurements

A dry filter paper disc is wiped over approximately 1 ft² of the surface being monitored. Swipes are counted for beta-gamma activity in a gas-flow proportional detector. Alpha activity of a swipe is determined by means of a gas-flow proportional detector and a scaler.

6.1.4 Airborne Contamination Measurements

In addition to using the fixed location or mobile particulate and gaseous continuous air monitors, particulate airborne activity will also be determined as needed by drawing a sufficient quantity of air through a filter paper. The samples are counted for beta-gamma activity in gas-flow proportional detector and scaler equipment. Alpha activity of a sample is determined by means of a gas-flow proportional detector and a scaler.

6.2 ROUTINE AREA MONITORING

LACBWR Health and Safety will perform surveys that are necessary for the designation of controlled areas. Surveys will include routine checking of areas for external radiation hazards and contamination, as well as for airborne radioactivity.

6.2.1 Preoperational

Prior to loading fuel into the reactor, LACBWR Health and Safety will completely survey all areas of LACBWR, including the containment area, the turbine building, and the waste treatment building, to establish background conditions in the plant. These surveys will be for gamma- and neutron-radiation and for airborne radioactivity, as well as for base readings in the waste disposal system. Data collected during these surveys will be used for comparison with data taken during routine surveys and during shielding surveys made while the plant is in operation.

6.2.2 Operational

Routine surveys will be conducted during the operation of the plant to establish hazard levels throughout the facility. Whenever possible, LACBWR Health and Safety will make the first entry into areas of unknown radiation levels. Otherwise, persons entering areas of unknown radiation levels will carry gamma- and neutron-survey meters to determine the radiation level. Data from all such surveys will be recorded in the LACBWR Health and Safety survey log.

6.2.3 Routine Area Surveys

During the initial background survey of the facility, the Health and Safety Engineer will establish a system for routine surveys of the facility during startup. This system will detail surveys to be made daily, weekly, and monthly. Information to be gathered during these surveys will include contamination levels (smears and meter readings), airborne activity levels, and radiation levels.

The results gained through the use of this system will determine when and where each survey is to be made. Since the system will be subject to change as experience in its use is gained, it will be published as a separate LACBWR Health and Safety procedures memorandum.

6.3 SPECIAL RADIOLOGICAL SURVEYS

Special radiation and contamination surveys, in addition to routine surveys, shall be made by LACBWR Health and Safety when necessary. Examples of situations requiring special surveys are:

- (1) during any test or work items involving:
 - (a) installation or removal of neutron test sources,
 - (b) installation or removal of core startup sources,

- (c) installation or removal of reactor components after initial criticality,
 - (d) fill of reactor vessel,
 - (e) loading fuel elements,
 - (f) the opening of a primary coolant system (make a special check of the surrounding area for contamination after the opening or removal operation has been completed and before other work is resumed),
 - (g) the removal of liquid from a primary coolant system, or the removal of any material which has been in contact with the primary coolant (i.e., valves, pumps, sections of piping, D/P cells, demineralizer resin, etc.), and
 - (h) during initial reactor operation after the initial installation of, and after repairs or modifications to, radiation shielding;
- (2) following any situation which may result in radioactive contamination,
 - (3) during any decontamination operation,
 - (4) checking shop areas in which contaminated equipment is being worked on,
 - (5) when rupture of a radioactive-material container occurs, or when spills are reported,
 - (6) when handling spent fuel,
 - (7) during foil or wire counting and removal from core,
 - (8) unconditional release of items to unrestricted areas, and
 - (9) on annunciation of high levels from the plant surveillance radiation monitoring system.

6.4 PROCEDURES FOR PERSONNEL ENTRY AND EXIT FROM RESTRICTED AREAS

6.4.1 Restricted Areas

Restricted areas are areas for which access shall be controlled because of an actual or potential hazard from radiation. These areas are the turbine building area, the containment building area, and the waste treatment building area. Control points will be established at the entrance to the turbine building from the change room in the office building, and at the entrance to the waste treatment building.

6.4.2 Entry

Normally, entry beyond control points will require film badges, pocket dosimeters, and the completion of a check-in log. (Protective clothing may be required if radioactive contamination is present.) Persons who perform special operations in high radiation areas, or in areas that are potentially capable of becoming contaminated, will require special instructions and complete protective clothing. A special work permit (SWP) is then required, and LACBWR Health and Safety should be contacted prior to any person's entry into the area. Procedures for obtaining a special work permit are outlined in Sec. 6.5.

6.4.3 Check-Out Procedures for Leaving Restricted Areas

All personnel and material must be checked for contamination before leaving restricted areas. Personnel may check themselves for contamination by using the hand and foot monitors and friskers provided at restricted area entrances. The unconditional release of equipment will be performed by LACBWR Health and Safety.

(1) While standing on the potentially contaminated side of the stepoff line, monitor protective clothing for contamination. If protective clothing does not exceed the limit set by LACBWR Health and Safety, replace it on the rack. If it does exceed the limit, put it in the laundry hamper. Then, check hands and body for contamination. This is done by slowly moving the probe across the body approximately 1 in. from the clothing surface. The head and hands are checked in the same manner.

(2) While still standing on the potentially contaminated side of the stepoff line, monitor one foot. If the foot is found to be free of contamination, place it down on the clean side of the stepoff line, and then survey the other foot. If the other foot is also free of contamination, move it onto the clean side of the line.

(3) Complete the Check-In/Check-Out log by inserting the required information.

(4) If contamination is detected, notify LACBWR Health and Safety for decontamination assistance. If LACBWR Health and Safety cannot be located, notify the Shift Supervisor and ask him for assistance; and proceed with the decontamination procedures listed below.

(a) Contaminated hands are to be washed with soap and water using the wash basins on the potentially contaminated side of the stepoff line.

(b) Contaminated clothing will be placed in a plastic bag and stored on the potentially contaminated side of the stepoff line.

(c) If the whole body has been contaminated, use the decontamination shower, washing with soap and water.

(d) Contaminated shoes are to be dabbed with the sticky side of the masking tape which is provided for that purpose. The tape is to be discarded in a receptacle on the potentially contaminated side of the stepoff line.

(e) After decontamination has been completed, always recheck.

6.4.4 Movement of Equipment and Material from Restricted Areas

No tools, equipment, supplies, or material shall be taken from the restricted areas without a release survey from LACBWR Health and Safety. Radioactivity levels of any material should meet the criteria set forth in Sec. 2.5 before this material is released to an unrestricted area. If radioactive material exceeding the permissible limits must be removed, LACBWR Health and Safety will specify the special precautions necessary for the material's removal.

6.5 USE OF SPECIAL WORK PERMITS

Work in certain areas within the restricted area of LACBWR, work on special components or systems, and work in high radiation areas and airborne contamination areas will require a special work permit. (See Appendix A-2 and its add-on sheet, Appendix A-3.)

Examples of the times when special work permits (SWP) may be required are included in Sec. 6.3. Generally, SWP's will be limited to nonroutine situations or to situations which involve a greater hazard than is normally present within the restricted area. An SWP can be used for hazardous work other than radioactive work. SWP's are used to assure personnel that they are adequately informed concerning the hazards of a particular job and that adequate controls have been taken to ensure the safe completion of the job. SWP's will be valid only when signed by LACBWR Health and Safety and by a Shift Supervisor. The SWP's will normally apply only for the period of the particular job. SWP's will contain the following information:

- (1) pertinent exposure rates or contamination levels,
- (2) time limits,
- (3) protective equipment and radiation survey instruments needed,
- (4) personnel monitoring equipment needed, and
- (5) special precautions required.

6.6 PROTECTIVE APPAREL AND EQUIPMENT

6.6.1 Location

Protective apparel and devices are kept in the change room, and a minimum supply of these are kept in the waste treatment building.

6.6.2 Description

6.6.2.1 Protective Apparel. Coveralls, lab coats, shoe covers, surgeon's caps, and gloves are available for use in areas where contamination is a possibility. This equipment is distinctively marked and should be used only as anti-contamination clothing.

6.6.2.2 Protective Equipment. Full face masks (with high efficiency filters) and self-contained air supply masks are available for use when inhalation of radioactive materials could occur. LACBWR Health and Safety will specify when this breathing apparatus should be used.

6.6.2.3 Decontamination Supplies. Stores of decontaminating materials will be kept in the change room and in the waste disposal building for the decontamination of personnel.

6.6.3 Use

Normally, laboratory coats will suffice when personnel are entering a restricted area. LACBWR Health and Safety will determine when additional protective apparel and equipment will be used according to:

- (1) the type of work,
- (2) the time to be spent in a restricted area, and
- (3) the type and degree of contamination.

Protective apparel shall be worn only in restricted areas. In general, instructions for protective equipment to be used will be specified on an SWP by LACBWR Health and Safety.

6.7 HANDLING OF USAEC LICENSED RADIOACTIVE MATERIAL

This section outlines the controls for storage, use, and transportation of standard radiation sources. These controls are:

- (1) All sources and/or source containers should be labeled with radiation signs, with the following information:

- (a) source type,
- (b) quantity,
- (c) date quantity measurement was made,
- (d) dose rate at normal handling point, and
- (e) leak test date and results.

(2) Sources will be controlled by LACBWR Health and Safety and will be in a locked container or cabinet. These sources will be stored at a location designated by LACBWR Health and Safety.

(3) Check-out cards on which to record the use of various sources and to authorize such use are provided by LACBWR Health and Safety. The user's signature is required on this record. (See Appendix A-4.)

(4) Sources are to be used, transported, and stored in such a way as to minimize personnel exposure to them. The sources shall be kept in their shielded containers except when they are in use. Sources without shielded containers shall be properly handled so that undue exposure does not result.

(5) No protective clothing is required for source handling, except as it may be required in the work area involved.

(6) Sealed sources will be leak-checked once every six months. (See Appendix A-10.)

6.8 CONTROLLING AIRBORNE RADIOACTIVE CONTAMINATION

6.8.1 During Normal Operations

During normal operations, the plant off-gas and containment ventilation systems are designed to control airborne radioactive contamination. Continuous air monitoring devices monitor the air to determine radioactivity concentration present. If high airborne contamination is detected, valves in these systems will be closed to minimize the amount of contaminated air to the environment. An investigation will immediately be conducted to determine the cause of the activity and to initiate corrective action.

6.8.2 During Maintenance Work

During maintenance work on radioactive components, some operations (i.e., grinding, machining, welding, etc.) on contaminated components may cause airborne radioactive

contamination. Generally, the following procedures will be effective in controlling airborne contamination:

(1) The containment of radioactive contamination will be accomplished by the use of suitable enclosures around potentially highly contaminated work. Exhaust ventilation from such spaces should be adequately filtered before being discharged into the external atmosphere.

(2) Radioactive dust and particles will be collected by local exhaust ventilation (absolute filtered vacuum cleaners) when contaminated components are ground, machined, welded, or wire-brushed. The dust collector shall run continuously while work is in progress, with the exhaust hose placed as close as possible to the work.

(3) Loose surface contamination which is a potential source of airborne contamination will be removed. Generally, regular wipedown of surface contamination to levels less than 4000 dpm/100 cm² will minimize airborne contamination. Loose surface contamination can also be temporarily controlled by temporary fixing or by covering the contaminant with material such as herculite or barrier paper.

(4) The use of wet handling techniques reduces the possibility of the contamination's spreading into the atmosphere. When surfaces are kept wet, dry contamination is less likely to flake or to get blown off. Wet handling can be accomplished by completely immersing the component or by otherwise keeping its surface wet. Normally, only pure water must be used to wet components.

6.8.3 Procedures for High Airborne Contamination

The procedures to be followed in the event of general airborne contamination above the radioactivity concentration guides are:

(1) The continuous air monitors are equipped with adjustable setpoints and will be set to alarm whenever the airborne contamination exceeds the permissible guides. When the alarm sounds, personnel should evacuate the building until the hazard can be evaluated and necessary precautions taken.

(2) Warning signs shall be posted delineating the area as an airborne contamination area. Access to such areas shall be restricted and controlled by LACBWR Health and Safety. Exposure times in airborne contamination areas will be based on concentrations of radioactive effluents. No time allowance will be made for use of respiratory protection.

(3) The use of respirators approved by LACBWR Health and Safety in addition to the use of normal anti-contamination clothing, will be required.

(4) Sources of airborne contamination should be removed or contained if possible. If the cause is widespread surface contamination, the area shall be decontaminated.

(5) If it is likely that general ventilation is contributing to the airborne contamination, the ventilating system shall be turned off. If the source of the contamination can be contained, then the general ventilation providing this source can be suitably filtered and can be used to remove airborne contamination.

6.9 TEMPORARY SHIELDING

The reactor is designed so that, during normal operations, the use of additional shielding will not be required. However, during maintenance work, and during work involving personnel exposure in high radiation areas for significant lengths of time, additional shielding may be required. In high radiation areas, shielding should be provided (i.e., lead sheet, lead bricks, or concrete bricks). Their purpose is to reduce radiation levels to a value which will allow personnel to work in such areas under normal conditions for an economical period of time. Whenever practicable, shielding will be provided to keep radiation levels as low as possible so that personnel exposure will be kept to a minimum. Generally, the need for shielding will be recommended by LACBWR Health and Safety. The consideration of temporary shielding will be a normal requirement in preparing procedures for maintenance on equipment in high radiation areas.

6.10 GENERAL TECHNIQUES FOR HANDLING AND WORKING WITH RADIOACTIVE MATERIAL

Controlling the spread of contamination will minimize the personnel health hazards and the costly, time-consuming decontamination involved. The proper application of techniques for handling and working with radioactive material shall serve to assist personnel in executing their jobs safely and economically. Whenever practical, it is desirable to mock up the work area and to conduct a dry run before doing the actual work.

Generally, the techniques for handling and working with radioactive material are:

(1) Avoid touching contaminated surfaces unnecessarily. When in doubt about contamination levels, consult LACBWR Health and Safety.

(2) Avoid touching uncontaminated surfaces with contaminated clothing, tools, and materials.

(3) Lay contaminated items and tools on disposable materials such as sheet poly, barrier paper, or absorbent paper.

(4) Contaminated tools and materials that are no longer needed at the job site shall be placed in poly bags and removed from the area as soon as practical.

(5) Incidental contamination of areas, tools, or equipment shall be cleaned immediately in compliance with the methods suggested by LACBWR Health and Safety.

(6) All working surfaces in the immediate vicinity of work involving radioactive materials shall be covered with disposable materials, such as sheet poly or barrier paper.

(7) The work area shall be cleaned frequently to prevent any buildup of radioactive waste, clean waste, or unnecessary equipment.

(8) Keep the work area confined to as small an area as possible without hindering work operations. Confinement is necessary to minimize the possibility of contaminating a significantly larger area than that in which the work is being done. A contamination control point may be required to help confine radioactive contamination.

(9) No personal tools or equipment shall be used for working on radioactive materials.

(10) All work on radioactive materials shall be accomplished under the cognizance and surveillance of LACBWR Health and Safety.

(11) A special work permit will be required for shop work on radioactive material.

(12) Radioactive materials should normally be moved only after they have been placed in a plastic bag or other suitable container to control contamination. These materials should also be monitored and labeled.

(13) Whenever grinding, machining, wire brushing, or welding operations are required on radioactive systems, exhaust ventilation shall be provided, with the exhaust tube placed as close as possible to the work being performed. If these operations are accomplished within a small, sealed, disposable-type glove box or similar type of containment, ventilation may not be required.

(14) Whenever a primary system pipe is cut, it shall be assumed that this pipe contains radioactive water. Necessary means to catch any spillage must be provided.

(15) Where dripping or leaking of contaminated water is possible or expected from pipe ends, valve connections, drain fittings, etc., this leakage shall be contained to minimize its being tracked throughout the building. Fireproof absorbent paper should be used to soak up any water.

(16) Avoid contact with the primary coolant except when necessary to contain or control a spill.

(17) Provisions shall be made to catch spillage when lines and piping which have previously carried primary coolant are being disconnected.

6.11 RADIOLOGICAL CONTROL LOGS

A radiological control operational log shall be maintained by LACBWR Health and Safety personnel so that a continuous record may be available to indicate the status of operations. An entry shall be made in the radiological control log whenever a radiological survey is performed. Examples of these surveys include reactor containment building surveys, generator building surveys, survey of decontaminated operations, and other radiological surveys. In addition to significant radiation and contamination levels, information such as the control measures imposed and work operations in progress shall also be entered. A survey diagram of the area surveyed shall be used to record radiological survey results in detail. Survey results on specific areas or items shall be recorded on LACBWR Health and Safety survey forms. Reference shall be made in the log book to the corresponding survey diagram or report form. (See Appendixes A-5, A-6, A-7, A-8, A-9, and A-10.)

The log books shall serve as permanent records of all health physics operations, and they will be filed indefinitely for future reference.

The following data, when applicable, shall be recorded in operational logs:

- (1) date, time, and location;
- (2) status of plant or of operation taking place;
- (3) results of any radiation and contamination surveys (include references to survey diagrams and reports when necessary);
- (4) radiological control measures imposed;
- (5) authority to whom control recommendations were given;
- (6) any incidents involving work operations;
- (7) operational deficiencies of any radiation detection equipment, scalars, etc., and action taken to correct deficiencies; and
- (8) any other pertinent information that may be required.

7. DECONTAMINATION

7.1 PERSONNEL

Because of the varying action taken according to the nature of the contaminant, detailed procedures for decontamination will not be given here. Showers and wash basin facilities are available for decontamination and shall be used only for that purpose. In general, the following progressively severe steps may be taken in removing contamination:

- (1) Flush the area with water.
- (2) Wash with mild soap.
- (3) Wash with detergent.
- (4) Scrub with scouring powder.
- (5) Use a cleaning agent (e.g., potassium permanganate).
- (6) Use oxalic acid (5 to 10 percent water solution). Oxalic acid should not be ingested and its use should always follow that of potassium permanganate.
- (7) Use citric acid (15 percent water solution).
- (8) Use a scrubbing brush during any of the foregoing steps.

All of the above steps are to be followed by a flush with plain water, LACBWR Health and Safety will determine when a given decontaminating agent other than soap (or detergent) and water will be used and must be consulted if there is a possibility that steps (4) through (8) might be used. In extreme cases, the advice of a physician may be necessary.

NOTE: The contaminated area is to be surveyed following each decontaminating step.

7.2 EQUIPMENT

Equipment will be decontaminated according to the general steps given in Sec. 7.1 with this exception; i.e., that concentrated solutions of acids or cleaning solutions may be used in some cases. Decontamination of reactor components should be investigated with operations personnel in order to ensure that the components do not sustain any damage. A minimum of water should be used to reduce the volume in the waste holdup system.

7.3 CLEANUP OF SURFACE CONTAMINATION IN RESTRICTED AREAS

When the pursuance of the procedures in Sec. 6 indicates a contaminated area, the area will be cleaned immediately. Although the nature of the contamination, its extent, and the surface on which it is found will ultimately determine the cleanup method, the following general procedures may be used:

- (1) If the area is dusty, first vacuum the area with a machine containing an absolute filter.
- (2) The area will be wet-mopped with a decontaminating agent and hot water.
- (3) The area will then be rinsed with clear water and damp-mopped.
- (4) The area will again be checked for contamination.
- (5) If contamination is still present, the area will be chemically cleaned.
- (6) If the area remains contaminated beyond allowable levels after chemical cleaning, other action will be taken. Further action may include the removal of paint from the surface; covering the surface to prevent further contamination, or the complete removal of the contaminated piece.

All decontamination will be directed by LACBWR Health and Safety. It is also responsible for the disposal of the contaminated water or other items used in decontamination. These operations will normally require an SWP. If immediate decontamination is precluded, suitable interim safeguards to prevent further spreading of contamination shall be instituted. These measures will include roping off the area or covering it with paper.

8. RADIOACTIVE MATERIAL DISPOSAL, STORAGE AND SHIPMENT

8.1 RADIOACTIVE LIQUID WASTE

Sources of liquid waste from the containment building and from the turbine building, as well as a discussion of liquid waste handling, waste treatment facilities and monitoring of liquid wastes are discussed in ACNP-64634, Final Safeguards Report for LACBWR. Radioactive liquid waste is drained into a liquid waste retention system. Depending on its solids content, liquid waste may be treated by ion exchange or by evaporation. All liquid waste will be sampled for radioactivity and may be released into the liquid waste water discharge line only with written approval from LACBWR Health and Safety. No release will be permitted that will result in the generation of radioactivity in unrestricted areas in concentrations that, averaged over one year, exceed those in Table II, Column 2, of 10 CFR 20 (Appendix B).

8.2 RADIOACTIVE GASEOUS WASTE

Sources of gaseous activity, waste gas handling systems, and monitoring systems are discussed in ACNP-64634, Final Safeguards Report for LACBWR. Gaseous wastes will be disposed through the stack. The following system is available to minimize airborne activity release.

(1) If the air ejector off-gas fission products monitor senses a concentration that would lead to 10 times the RCG ground concentration when averaged over the period of one year, an alarm is given and, also, an automatic valve closure will occur to prevent further release to the stack.

(2) If the containment building air exhaust gaseous or particulate activity is such that either the gaseous or particulate activity, averaged over a year's time, would result in an exposure of 10 times the radioactivity concentration guide, then an alarm is given and the ventilation dampers are automatically closed.

(3) An alarm is given if the stack gaseous or particulate concentration is such that the RCG, when averaged over one year, will be exceeded. Corrective action can then be taken. For example, gaseous release from the gas storage tanks will not be permitted while a condition exists in which the RCG is exceeded. If 10 RCG is reached, a control valve in the reactor plant vent header is closed, and gases will then flow to the storage tanks instead of to the stack.

8.3 RADIOACTIVE SOLID WASTE

The resins of the primary purification system are the major sources of solid wastes. Resins are sluiced into the 1000-gal spent-resin tank in the waste-treatment facility, where they are temporarily stored and allowed to decay.

The resins are then packaged in 55-gal drums for shipment to an authorized disposal site. The waste-treatment facility incorporates means for drumming spent resins and concentrated liquid waste from the evaporator by mixing them with concrete in a 55-gal drum.

Items such as contaminated clothing are collected in drums and sent to a licensed contaminated-laundry facility. Radioactive laboratory glassware and other contaminated solid wastes are packaged in drums for off-site disposal.

8.4 STORAGE OF RADIOACTIVE MATERIAL

A dry-storage pit in the waste-treatment facility may be used for temporary storage of the drums until their activity decays enough to permit either outside storage or shipment to an authorized disposal site.

All radioactive material, including material being temporarily stored for waste disposal, decontamination, or other work shall be stored in properly secured and controlled areas with appropriate signs and markings. (See Sec. 3.)

Areas in which radioactive material is routinely stored shall be monitored periodically by LACBWR Health and Safety to reevaluate radiation hazards.

8.5 SHIPMENT OF RADIOACTIVE MATERIALS

8.5.1 Packaging, Labeling, and Survey

Solid and liquid wastes and other radioactive materials which are to be shipped will be handled according to AEC Manual Chapter 0529 and the pertinent ICC, FAA, Coast Guard, and Post Office regulations.

8.5.2 Certification of Shipments

After final preparations for shipment have been made, LACBWR Health and Safety shall monitor all containers to determine compliance with applicable regulations. Appropriate labels will be attached, and LACBWR Health and Safety will place the following certification on applicable shipping documents:

"This is to certify that the above-named articles are properly described, and are packed and marked and are in proper condition for transportation according to regulations prescribed by the ICC."

For parcel post shipments, the following certification will be made on the package:

"Radioactive Material - Gamma Radiation at Surface of Parcel Less than 10 Milliroentgens for 24 Hours - No significant Alpha, Beta, or Neutron Radiation."

A receipt for all radioactive materials shipped from the site shall be requested from the recipient to ensure the arrival of material at its destination.

8.5.3 Shipping Checklist

The shipment of radioactive material must be made to a person or organization authorized by the USAEC to receive the material. The checklist shown in Appendix A-11 is to be used when shipping radioactive material.

8.6 RECORDS

LACBWR Health and Safety shall maintain records of all radioactive liquid and gaseous wastes discharged to the environment. They shall also maintain records of all radioactive material shipped from the site.

9. ORIENTATION AND TRAINING

9.1 PERSONNEL INDOCTRINATION

LACBWR Health and Safety will provide a general orientation for all new employees who will normally work in radiologically controlled areas. The general indoctrination procedures for new employees are:

- (1) Film badge assignment;
- (2) Explanation of the reasons for using film badges and self-reading pocket dosimeters;
- (3) Dosimeter assignment (if needed);
- (4) Sending out letters requesting data on previous radiation exposure (if any);
- (5) Instructing personnel to read a copy of the health physics volume of the Operating Manual, and pointing out each person's responsibilities (i.e., the individual's, the supervisor's, and the health physics technician's);
- (6) Explaining the philosophy of contamination control;
- (7) Discussing the effects of radiation, and permissible doses;
- (8) Briefing individuals on general safety and industrial hygiene;
- (9) Obtaining a urine specimen from each individual to establish that individual's basic body burden;
- (10) Explaining the procedure for bringing visitors into restricted areas; and
- (11) Giving to the new personnel copies of any reading material they need for their work.

The foregoing initial procedures are followed up by detailed instruction on each specific case in which a person comes in contact with a new type of hazard. The point must be clearly made that, in the event he is confronted with a new and unknown situation, the responsibility for obtaining information rests with the individual.

9.2 HEALTH PHYSICS TRAINING

LACBWR Health and Safety will provide health physics training to all personnel involved in the operation of the reactor. This training will include the dissemination of information which is necessary for personnel to perform their functions safely. The training program will be about 20 hr long. The outline of topics to be discussed is:

- (1) Introduction
- (2) Basic Health Physics Units
- (3) Radiation Protection Standards
- (4) Basic Radiation Protection
- (5) Radiation Detection
- (6) A Basic Health Physics Program
 - (a) Basic Philosophy
 - (b) Area Monitoring
 - (c) Process Monitoring
 - (d) Surveys
 - (e) Personnel Monitoring
 - (f) Decontamination
 - (g) Waste Disposal
 - (h) Environmental Monitoring
 - (i) Records
- (7) Disasters and Emergencies
- (8) Examination

Appendixes A-12 through A-15 are included as an aid in general orientation.

APPENDIX A

HEALTH AND SAFETY FORMS

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

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

[illegible]**LIFETIME ACCUMULATED DOSE**

14. PREVIOUS TOTAL	15. TOTAL DOSE RECORDED ON THIS SHEET	16. TOTAL ACCUMULATED DOSE	17. PERM. ACC. DOSE	18. PERMISSIBLE DOSE
rem	rem	rem	5(N-18)= rem	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 $1\frac{1}{4}$ 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 measurement 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. All measurements are to be interpreted in the best method known and in accordance with Section 20.4(c). A description of the method of analyzing the monitoring results in terms of dose 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 $1\frac{1}{4}$ 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.

LACBWR-18
LACBWR SPECIAL WORK PERMIT

Permit No. _____

ORIGINATOR AND OPERATION DEPT.	Requested By _____ Dept. _____		Before starting work, Operations Dept. Supervisor on duty and Health & Safety Department MUST BE NOTIFIED!					
	Lock & Tag Procedure required. Yes _____ No _____							
Job Location _____								
Job Description _____								
Date of Request _____ Work to Begin _____ Work to End _____								
HEALTH & SAFETY AND ORIGINATOR	NAME AND IDENTIFICATION NUMBER OF ALL PERSONS COVERED BY THIS FORM							
	NAME	Payroll No.	Avail. Exposure	Dose Received	NAME	Payroll No.	Avail. Exposure	Dose Received
HEALTH AND SAFETY DEPARTMENT	PROTECTIVE EQUIPMENT REQUIREMENTS							
	PERSONNEL METERS	HANDS	BODY	FEET	HEAD	RESPIRATORY		
	☐ Film Badge	☐ Canvas Gloves	☐ Coveralls	☐ Acid Boots	☐ Cotton Caps	☐ Full Face		
	☐ Neutron Badge	☐ Rubber Gloves	☐ Labcoat	☐ Rubbers 12"	☐ Goggles	☐ Ultra Filter		
	☐ Gamma Pencils	☐ Leather Gloves	☐ Waterproof	☐ Shoecovers	☐ Waterproof Hood	☐ Chem. Filter		
	☐ Finger Rings	☐ Gauntlets	☐ Coveralls	☐ Toe Caps	☐ Hard Hat	☐ Self-Contained		
	☐ _____	☐ _____	☐ Acid Apron	☐ _____	☐ Face Shield	☐ Demand Mask		
			☐ _____		☐ _____	☐ Dust Half Mask		
	SPECIAL REQUIREMENTS				RADIATION MEASUREMENTS (At time of H&S Approval)			
	☐ Fire Protection		☐ Health Physics Coverage Req.		Beta _____ mrem/hr			
☐ Fire Watch		☐ Intermittent		Gamma _____ mrem/hr				
☐ Tool Survey		☐ Continuous		Neutron _____ mrem/hr				
☐ Personnel Survey		☐ At Start of Job		TOTAL _____ mrem/hr				
☐ Oxy. Deficiency Test		☐ At Completion of Job		CONTAMINATION LEVEL _____				
☐ Percent Oxygen _____		☐ Timekeeper Required						
☐ Explosive Vapor Test								
SPECIAL INSTRUCTIONS - _____								
APPROVALS	APPROVALS FOR PERFORMING WORK							
	Job Supervisor - _____				Date - _____			
	Operations Dept. Supervisor _____				Date - _____			
	Health & Safety Engineer _____				Date - _____			
TERMINATION OF PERMIT	PERMIT TERMINATED BY _____ Date _____ (Operations Dept. Supv.)							
	REASON							
	Completion of Work		Cancellation		Condition Changes			
	*Indicates Understanding and Compliance							

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4/5/68

CONTINUATION SHEET FOR LACBWR SPECIAL WORK PERMIT

Permit No. _____

NAME AND IDENTIFICATION NUMBER OF ALL PERSONS COVERED BY THIS FORM					
HEALTH & SAFETY AND ORIGINATOR	NAME	Payroll No.	Avail. Exposure	Dose Received	*Initials

RADIOISOTOPE INVENTORY DATA

Isotope _____ Source No. _____

Current Consignee _____ Location _____

Activity _____ On _____ Half Life _____

Chemical and/or Physical Form _____

Radiation Emitted

_____	_____
_____	_____
_____	_____
_____	_____

Dose at 1 meter _____ Determined By _____

Smear Test Results _____ On _____

Date Received _____ Supplier _____

Model No. _____

AEC License No. _____ Expires _____

Source May Be Used

At _____

By _____

Comments _____

L-51

RADIATION SURVEY RECORD

LOCATION	TIME PERIOD To	DATE	NUMBER
Description of Job			

INSTRUMENT READINGS

[illegible]

CORRECTED DOSE RATES TO PERSONNEL

[illegible]

Timekeeping Required ☐ YES ☐ NO		RESPIRATORY PROTECTION WORN ☐ SUPPLIED AIR ☐ FILTER ☐ NONE		RWP NUMBER
MAX. UNCORRECTED MEASUREMENT MADE:		MAX. CORRECTED DOSE RATE:		SIGNED:

DESCRIPTION OF NEUTRON MEASUREMENT

MEASUREMENT NUMBER	DOSE RATES IN mREM/HOUR			
	FAST NEUTONS	INTERMEDIATE NEUT.	SLOW NEUTRONS	TOTAL

COMMENTS:

ACTION TAKEN:

RECOMMENDED FOLLOW-UP:

SKETCH, IF NEEDED:

CARBON COPY SENT TO:

ABBREVIATIONS

F - FIELD
C - CONTACT
Ft - FEET
IN - INCH

Ft - SQUARE FEET
IN - SQUARE INCHES
WO - WINDOW OPEN

INSTRUCTIONS FOR COMPLETING FORM

This form is to be used in the counting and calculation of air samples. The blank spaces, when filled in, provide the information necessary to calculate the sample activity in microcuries per cubic centimeter and a three-point decay curve for short lived activity.

1. LOCATION: Complete description of sample location. Include height from floor, etc.
2. DATE: Date the sample was taken.
3. INSTRUMENT USED: Number of the air sampler used.
4. SAMPLE VOL: Total volume of air sampled in cubic centimeters.
5. TIME ON: Time sampler was started.
6. TIME OFF: Time sampler was shut off.
7. TOTAL TIME: Total time sampler was running in minutes.
8. SAMPLED BY: Signature of person who obtained the sample.
9. COUNTER USED: Identify the counter used by number, etc.
10. BACKGROUND: Background cpm obtained prior to counting sample.
11. EFFICIENCY: Efficiency (%) of the counter used.
12. TIME: Time the count was started.
13. COUNTS: Total counts indicated by the scaler.
14. TIME (min): Total number of minutes of count.
15. c/m: Divide the total counts by the time (min) to obtain counts per minute.
16. c/m-b: Subtract the counter background from the c/m and enter the remainder.
17. d/m: Multiply c/m-b times the counter efficiency factor times the sample size correction factor and enter the product as d/m.
18. uCi/cc: Calculate uc/cc by the formula:
$$\frac{\text{Sample d/m}}{\text{Sample volume(cc)} \times 2.22 \times 10^6} = \text{uCi/cc}$$

Where
 2.22×10^6 equals d/m/uCi

19. IMMEDIATE COUNT: The count taken as soon as possible after removing the filter from the sampler.
20. BLANK COUNTS: Provided for counts taken shortly after immediate count. Actual time after immediate count to be filled in by counter operator.
21. 4-6 hr COUNT: The count taken 4 to 6 hours after the immediate count.
22. 24 hr. COUNT: The count taken 24 hrs after the immediate count.
23. REMARKS: Any pertinent information should be included under this section such as filter size correction factor, conditions under which sample was taken, etc.
24. COUNTED BY: Signature of person doing the counting and calculation of sample.

INSTRUCTIONS FOR COMPLETING FORM

The Air Sample Summary Report serves as a running record of air sample activity for a given area. This makes it easier to pick out trends in any one location and facilitates the preparation of air sample reports at a later date.

1. LOCATION: Enter the general location such as building, level, room, etc.
2. DATE & TIME: Date and time each sample was taken.
3. SAMPLER LOCATION: Specific location of sampler such as distance from floor, center of room, etc.
4. VOLUME (cc): Total volume of air sampled in cc for each sample.
5. D/M: The number of disintegrations per minute, both alpha and beta-gamma, for each sample. Be sure the d/m has been corrected for any sample size difference before entering.
6. CONCENTRATION: ($\mu\text{Ci/cc}$) Write in the concentration for both alpha and beta-gamma for each sample.
7. REMARKS: Any information which may be needed to qualify or explain a sample.

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WATERBORNE RADIOACTIVITY SURVEY

Date _____ Counter _____ Surveyor _____
Bkgd. _____

Location or Sample Pt.	Sample Volume (ml)	Count Rate (c/m)	Counter Efficiency (0/0)	Disintegration Rate (d/m)	Concentration (μ c/ml)	Action Recommended (if any)

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SMEAR SURVEY

Date _____ Counter _____ Surveyor _____

Bkgd. _____

Location (or Equipment)	Counts/min per 1 ft ²		Efficiency (0/0)	Disintegration/min per 1 ft ²		Action Recommended (if any)
	(alpha)	(beta) (gamma)		(alpha)	(beta) (gamma)	

SEALED SOURCE LEAK TEST SURVEY

Date _____ Counter _____ Surveyor _____

Bkgd. _____

Source Description	Smear Method	Count Rate (c/m)	Counter Efficiency (0/0)	Disintegration Rate (d/m)	Contamination (μ c)	Action Recommended (if any)

FORM FOR SHIPPING RADIOACTIVE MATERIAL

Description						
Material						
	Solid		Liquid		Powder	Gas
Physical Form						
					Maximum Allowable	
Millicuries						
Method of Transportation						
	Remarks					
Bureau of Explosive Permit (if required)						
Surface Radiation	Alpha		Gamma		Total	
	Beta		Neutron			
2R Container (if required)						
ICC-55 specification markings (if required)						
ICC specification markings (if required)						
Dimensions of Container						
Surface Contamination						
Labeling required						
Flammability Label (if required)						
Special Consideration required because of criticality (if required)						

SPENT FUEL
STORAGE WELL

CONTAINMENT BUILDING

GENERATOR PLANT
& REACTOR PLANT
CONTROL ROOM

TURBINE BUILDING

EXCITATION
SWITCHGEAR

RESERVE
EXCITER

60,000 KW
TURBINE

CONDENSER
& EXHAUST

2400 VOLT
SWITCHGEAR 1B

2400 VOLT
SWITCHGEAR 1A

CONFERENCE
ROOM

AEC
OFFICE

MAIN FLOOR OF TURBINE BLDG, EL. 668' -0"

FIG. 10.1

A-13

SPENT FUEL
STORAGE WELL

CONTAINMENT BUILDING

TURBINE BUILDING

STEAM JET
AIR EJECTOR

MEZZANINE FLOOR OF TURBINE BLDG, EL. 654' -0"

FIG. 10.2

GRADE FLOOR OF TURBINE BLDG, EL. 640' -0"

FIG. 10.3

CONTAINMENT BUILDING ELEVATION

FIG. 10.4

APPENDIX B

10 CFR 20 STANDARDS FOR PROTECTION AGAINST RADIATION, USAEC,
WITH REVISIONS

UNITED STATES ATOMIC ENERGY COMMISSION

RULES and REGULATIONS • TITLE 10 - ATOMIC ENERGY

**PART
20****STANDARDS FOR PROTECTION AGAINST RADIATION****GENERAL PROVISIONS**

- Sec.
20.1 Purpose.
20.2 Scope.
20.3 Definitions.
20.4 Units of radiation dose.
20.5 Units of radioactivity.
20.6 Interpretations.
20.7 Communications.

**PERMISSIBLE DOSES, LEVELS, AND
CONCENTRATIONS**

- 20.101 Exposure of individuals to radiation in restricted areas.
20.102 Determination of accumulated dose.
20.103 Exposure of individuals to concentrations of radioactive material in restricted areas.
20.104 Exposure of minors.
20.105 Permissible levels of radiation in unrestricted areas.
20.106 Concentrations in effluents to unrestricted areas.
20.107 Medical diagnosis and therapy.
20.108 Orders requiring furnishing of bioassay services.

PRECAUTIONARY PROCEDURES

- 20.201 Surveys.
20.202 Personnel monitoring.
20.203 Caution signs, labels, and signals.
20.204 Exceptions from posting requirements.

- 20.206 Instruction of personnel; posting of notices to employees.
20.207 Storage of licensed materials.

WASTE DISPOSAL

- 20.301 General requirement.
20.302 Method for obtaining approval of proposed disposal procedures.
20.303 Disposal by release into sanitary sewerage systems.
20.304 Disposal by burial in soil.
20.305 Treatment or disposal by incineration.

RECORDS, REPORTS, AND NOTIFICATION

- 20.401 Records of surveys, radiation monitoring, and disposal.
20.402 Reports of theft or loss of licensed material.
20.403 Notifications of incidents.
20.404 Report to former employees of exposure to radiation.
20.405 Reports of overexposures and excessive levels and concentrations.
20.406 Notice to employees of exposure to radiation.

EXCEPTIONS AND ADDITIONAL REQUIREMENTS

- 20.501 Applications for exemptions.
20.502 Additional requirements.

ENFORCEMENT

- 20.601 Violations.

Appendix A—[Reserved]

Appendix B—Permissible Concentrations in air and water above natural background.

Appendix C.

Appendix D—United States Atomic Energy Commission Operations offices.

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) The first period of any year may begin on any date in January; provided that the second, third and fourth periods accordingly begin on the same date in April, July, and October, respectively, and that the fourth period extend into January of the succeeding year, if necessary to complete a three-month quarter. During the first year of use of this method of determination by a licensee, the first period for that year shall also include any additional days in January preceding the starting date for the first period.

(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.

*Alternatively, the four periods may consist of the first 14 complete, consecutive calendar weeks; the next 12 complete, consecutive calendar weeks; the next 14 complete, consecutive calendar weeks; and the last 12 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;

*Added 25 FR 13952

August 9, 1966

PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

(7) "Individual" means any human being;

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

(9) "License" means a license issued under the regulations in 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 for purposes of protection of individuals from exposure to radiation and radioactive materials. "Restricted area" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area;

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

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

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

(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/cm ²)	Average flux to deliver 100 millirem in 40 hours (neutrons/cm ² per sec.)
Thermal.....	970×10 ⁴	670
0.0001.....	720×10 ⁴	500
0.005.....	820×10 ⁴	570
0.02.....	400×10 ⁴	280
0.1.....	120×10 ⁴	80
0.5.....	43×10 ⁴	30
1.0.....	26×10 ⁴	18
2.5.....	29×10 ⁴	20
5.0.....	26×10 ⁴	18
7.5.....	24×10 ⁴	17
10.....	24×10 ⁴	17
10 to 30.....	14×10 ⁴	10

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

§ 20.5 Units of radioactivity.

(a) Radioactivity is commonly, and for purposes of the regulations in this part shall be, measured in terms of disintegrations per unit time or in curies. One curie (c)=3.7×10¹⁰ disintegrations per second (dps)=2.2×10¹² disintegrations per minute (dpm). A commonly used submultiple of the curie is the microcurie (μc). One μc=0.000001 c=3.7×10⁴ dps=2.2×10⁶ 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 10⁻¹ 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 ⁻⁴	0.16
1.....	4.5×10 ⁻⁴	0.10
2.....	1.3×10 ⁻⁴	0.028
3.....	0.3×10 ⁻⁴	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.

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(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 Th²³² plus 3.7×10^{10} dis/sec from Th²³⁰.

(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.

Except where otherwise specified in this part, all communications and reports concerning the regulations in this part, and applications filed under them, should be addressed to the Director of Regulation, U.S. Atomic Energy Commission, Washington, D.C., 20545. Communications, reports and applications may be delivered in person at the Commission's offices at 1717 H Street NW., Washington, D.C.; at 4915 St. Elmo Avenue, Bethesda, Md.; or 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 in-

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

§ 20.102 Determination of accumulated dose.

(a) This section contains requirements which must be satisfied by licensees who propose, pursuant to paragraph (b) of § 20.101, to permit individuals in a restricted area to receive exposure to radiation in excess of the limits specified in paragraph (a) of § 20.101.

(b) Before permitting any individual in a restricted area to receive exposure to radiation in excess of the limits specified in paragraph (a) of § 20.101, each licensee shall:

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

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

(c) (1) In the preparation of Form AEC-4, or a clear and legible record containing all the information required in that form, the licensee shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. For each period for which the licensee obtains such reports, the licensee shall use the dose shown in the report in preparing the form. In any case where a licensee is unable to obtain reports of the individual's occupational dose for a previous complete calendar quarter, it shall be assumed that the individual has received the occupational dose specified in whichever of the following columns apply:

Part of body	Column 1 Assumed exposure in rems for calendar quarters prior to Jan. 1, 1961	Column 2 Assumed exposure in rems for calendar quarters beginning on or after Jan. 1, 1961
Whole body, gonads, active blood-forming organs, head and trunk, lens of eye.	3¾	1¼

(2) The licensee shall retain and preserve records used in preparing Form AEC-4.

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

§ 20.103 Exposure of individuals to concentrations of radioactive 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 quanti-

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

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

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

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

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

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

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

(i) chemical composition;

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

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

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

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

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

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

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

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

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

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

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

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

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

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§ 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.

¹ Or "Danger."

§ 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:

CAUTION¹ RADIATION AREA

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

CAUTION¹ HIGH RADIATION AREA

(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:

CAUTION¹

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:

CAUTION¹

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 bearing the radiation caution symbol and the words:

CAUTION

RADIOACTIVE MATERIAL(S)

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

(2) A label required pursuant to subparagraph (1) of this paragraph shall bear the radiation caution symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL". It shall also provide sufficient information¹ to permit individuals handling or using the containers, or working in the vicinity thereof, to take precautions to avoid or minimize exposures.

(3) Notwithstanding the provisions of subparagraph (1) of this paragraph, labeling is not required:

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

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

(iii) For containers that do not contain licensed materials in concentrations

¹ As appropriate, the information will include radiation levels, kinds of material, estimate of activity, date for which activity is estimated, mass enrichment, etc.

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greater than the applicable concentrations listed in Column 2, Table I, Appendix B of this part.

(iv) For containers when they are attended by an individual who takes the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established by the regulations in this part.

(v) For containers when they are in transport and packaged and labeled in accordance with regulations of the Interstate Commerce Commission, Federal Aviation Agency, or Coast Guard.

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

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

§ 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.

(d) A room or other area is not required to be posted with a caution sign because of the presence of radioactive materials packaged and labeled in accordance with regulations of the Interstate Commerce Commission, Federal Aviation Agency, or Coast Guard.

§ 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 expo-

sure; 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 employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.

NOTE: Copies of Form AEC-3, "Notice to Employees," may be obtained by writing to the Director of the appropriate U.S. Atomic Energy Commission Regional Compliance Office listed in Appendix "D" or the Director, Division of Materials Licensing, U.S. Atomic Energy Commission, Washington, D.C., 20545.

§ 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.

The Commission will not approve any application for a license to receive licensed material from other persons for disposal on land not owned by the Federal government or by a State government.

§ 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.

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

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§ 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(b) and 20.302

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 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 paragraph (a) of this section shall be preserved until December 31, 1970, or until a date 5 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, 1970, 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 Director of the appropriate Atomic Energy Commission Regional Compliance 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.

§ 20.103 Notifications of incidents.

(a) **Immediate notification.** Each licensee shall immediately notify the Director of the appropriate Atomic Energy Commission Regional Compliance Office shown in Appendix D by telephone and telegraph of any incident involving by-product, 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 Director of the appropriate Atomic Energy Commission Regional Compliance 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.

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

§ 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 Compliance, U.S. Atomic Energy Commission, Washington, D.C., 20545

with a copy to the Director of the appropriate Atomic Energy Commission Regional Compliance Office listed in Appendix D, 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.

(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.

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

§ 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

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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]

25 FR 10914

APPENDIX B
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
[See notes at end of appendix]

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—CONTINUED
[See notes at end of appendix]

Element (atomic number)	Isotope	Table I		Table II	
		Column 1 Air ($\mu\text{Ci}/\text{m}^3$)	Column 2 Water ($\mu\text{Ci}/\text{m}^3$)	Column 1 Air ($\mu\text{Ci}/\text{m}^3$)	Column 2 Water ($\mu\text{Ci}/\text{m}^3$)
Actinium (89)	Ac 227 Ac 228 Am 241 Am 242m Am 242 Am 243 Am 244	2×10^{-11} 8×10^{-11} 8×10^{-11} 2×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	6×10^{-11} 9×10^{-11} 3×10^{-11} 3×10^{-11} 4×10^{-11} 1×10^{-11} 1×10^{-11}	8×10^{-11} 9×10^{-11} 3×10^{-11} 2×10^{-11} 2×10^{-11} 2×10^{-11} 1×10^{-11}	2×10^{-11} 3×10^{-11} 9×10^{-11} 9×10^{-11} 4×10^{-11} 1×10^{-11} 1×10^{-11}
Americium (95)	Am 242m Am 242 Am 243	2×10^{-11} 6×10^{-11} 1×10^{-11}	1×10^{-11} 3×10^{-11} 3×10^{-11}	4×10^{-11} 6×10^{-11} 2×10^{-11}	2×10^{-11} 4×10^{-11} 2×10^{-11}
Antimony (51)	Sb 122 Sb 124 Sb 125	2×10^{-11} 2×10^{-11} 3×10^{-11}	1×10^{-11} 8×10^{-11} 7×10^{-11}	8×10^{-11} 5×10^{-11} 7×10^{-11}	3×10^{-11} 3×10^{-11} 2×10^{-11}
Argon (18)	Ar 37 Ar 39 Ar 40	2×10^{-11} 2×10^{-11} 2×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11}	4×10^{-11} 1×10^{-11} 1×10^{-11}	5×10^{-11} 3×10^{-11} 1×10^{-11}
Arsenic (33)	As 74 As 76 As 77	2×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 2×10^{-11} 2×10^{-11}	1×10^{-11} 4×10^{-11} 3×10^{-11}	5×10^{-11} 5×10^{-11} 2×10^{-11}
Astatine (85)	At 211	1×10^{-11}	2×10^{-11}	1×10^{-11}	2×10^{-11}
Barium (56)	Ba 131 Ba 140 Ba 146	1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11}	2×10^{-11} 2×10^{-11} 2×10^{-11}
Berkelium (97)	Bk 249 Bk 250	1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11}
Beryllium (4)	Be 7	1×10^{-11}	1×10^{-11}	1×10^{-11}	1×10^{-11}
Bismuth (83)	Bi 206 Bi 207 Bi 210 Bi 212	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}
Bromine (35)	Br 82	1×10^{-11}	1×10^{-11}	1×10^{-11}	1×10^{-11}
Cadmium (48)	Cd 109 Cd 113m Cd 115	1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11}
Calcium (20)	Ca 45 Ca 47	1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11}
Californium (98)	Cf 249 Cf 250 Cf 251 Cf 252	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}
Cerium (58)	Ce 136 Ce 137 Ce 138 Ce 139 Ce 140 Ce 141 Ce 142 Ce 143 Ce 144	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}
Chlorine (17)	Cl 36 Cl 38 Cl 39 Cl 40	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}
Chromium (24)	Cr 51 Cr 52 Cr 53 Cr 54	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}
Cobalt (27)	Co 57 Co 58m Co 58 Co 60 Co 64	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}
Copper (29)	Cu 64	1×10^{-11}	1×10^{-11}	1×10^{-11}	1×10^{-11}
Curtium (96)	Cm 242 Cm 243 Cm 244 Cm 245 Cm 246 Cm 247 Cm 248 Cm 249	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}
Dysprosium (66)	Dy 165 Dy 166 Dy 167 Dy 168 Dy 169	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}	1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11} 1×10^{-11}
Einsteinium (99)	Es 253 Es 254 Es 255 Es 256 Es 257 Es 258 Es 259 Es 260 Es 261 Es 262 Es 263 Es 264 Es 265 Es 266 Es 267 Es 268 Es 269 Es 270 Es 271 Es 272 Es 273 Es 274 Es 275 Es 276 Es 277 Es 278 Es 279 Es 280 Es 281 Es 282 Es 283 Es 284 Es 285 Es 286 Es 287 Es 288 Es 289 Es 290 Es 291 Es 292 Es 293 Es 294 Es 295 Es 296 Es 297 Es 298 Es 299 Es 300 Es 301 Es 302 Es 303 Es 304 Es 305 Es 306 Es 307 Es 308 Es 309 Es 310 Es 311 Es 312 Es 313 Es 314 Es 315 Es 316 Es 317 Es 318 Es 319 Es 320 Es 321 Es 322 Es 323 Es 324 Es 325 Es 326 Es 327 Es 328 Es 329 Es 330 Es 331 Es 332 Es 333 Es 334 Es 335 Es 336 Es 337 Es 338 Es 339 Es 340 Es 341 Es 342 Es 343 Es 344 Es 345 Es 346 Es 347 Es 348 Es 349 Es 350 Es 351 Es 352 Es 353 Es 354 Es 355 Es 356 Es 357 Es 358 Es 359 Es 360 Es 361 Es 362 Es 363 Es 364 Es 365 Es 366 Es 367 Es 368 Es 369 Es 370 Es 371 Es 372 Es 373 Es 374 Es 375 Es 376 Es 377 Es 378 Es 379 Es 380 Es 381 Es 382 Es 383 Es 384 Es 385 Es 386 Es 387 Es 388 Es 389 Es 390 Es 391 Es 392 Es 393 Es 394 Es 395 Es 396 Es 397 Es 398 Es 399 Es 400 Es 401 Es 402 Es 403 Es 404 Es 405 Es 406 Es 407 Es 408 Es 409 Es 410 Es 411 Es 412 Es 413 Es 414 Es 415 Es 416 Es 417 Es 418 Es 419 Es 420 Es 421 Es 422 Es 423 Es 424 Es 425 Es 426 Es 427 Es 428 Es 429 Es 430 Es 431 Es 432 Es 433 Es 434 Es 435 Es 436 Es 437 Es 438 Es 439 Es 440 Es 441 Es 442 Es 443 Es 444 Es 445 Es 446 Es 447 Es 448 Es 449 Es 450 Es 451 Es 452 Es 453 Es 454 Es 455 Es 456 Es 457 Es 458 Es 459 Es 460 Es 461 Es 462 Es 463 Es 464 Es 465 Es 466 Es 467 Es 468 Es 469 Es 470 Es 471 Es 472 Es 473 Es 474 Es 475 Es 476 Es 477 Es 478 Es 479 Es 480 Es 481 Es 482 Es 483 Es 484 Es 485 Es 486 Es 487 Es 488 Es 489 Es 490 Es 491 Es 492 Es 493 Es 494 Es 495 Es 496 Es 497 Es 498 Es 499 Es 500 Es 501 Es 502 Es 503 Es 504 Es 505 Es 506 Es 507 Es 508 Es 509 Es 510 Es 511 Es 512 Es 513 Es 514 Es 515 Es 516 Es 517 Es 518 Es 519 Es 520 Es 521 Es 522 Es 523 Es 524 Es 525 Es 526 Es 527 Es 528 Es 529 Es 530 Es 531 Es 532 Es 533 Es 534 Es 535 Es 536 Es 537 Es 538 Es 539 Es 540 Es 541 Es 542 Es 543 Es 544 Es 545 Es 546 Es 547 Es 548 Es 549 Es 550 Es 551 Es 552 Es 553 Es 554 Es 555 Es 556 Es 557 Es 558 Es 559 Es 560 Es 561 Es 562 Es 563 Es 564 Es 565 Es 566 Es 567 Es 568 Es 569 Es 570 Es 571 Es 572 Es 573 Es 574 Es 575 Es 576 Es 577 Es 578 Es 579 Es 580 Es 581 Es 582 Es 583 Es 584 Es 585 Es 586 Es 587 Es 588 Es 589 Es 590 Es 591 Es 592 Es 593 Es 594 Es 595 Es 596 Es 597 Es 598 Es 599 Es 600 Es 601 Es 602 Es 603 Es 604 Es 605 Es 606 Es 607 Es 608 Es 609 Es 610 Es 611 Es 612 Es 613 Es 614 Es 615 Es 616 Es 617 Es 618 Es 619 Es 620 Es 621 Es 622 Es 623 Es 624 Es 625 Es 626 Es 627 Es 628 Es 629 Es 630 Es 631 Es 632 Es 633 Es 634 Es 635 Es 636 Es 637 Es 638 Es 639 Es 640 Es 641 Es 642 Es 643 Es 644 Es 645 Es 646 Es 647 Es 648 Es 649 Es 650 Es 651 Es 652 Es 653 Es 654 Es 655 Es 656 Es 657 Es 658 Es 659 Es 660 Es 661 Es 662 Es 663 Es 664 Es 665 Es 666 Es 667 Es 668 Es 669 Es 670 Es 671 Es 672 Es 673 Es 674 Es 675 Es 676 Es 677 Es 678 Es 679 Es 680 Es 681 Es 682 Es 683 Es 684 Es 685 Es 686 Es 687 Es 688 Es 689 Es 690 Es 691 Es 692 Es 693 Es 694 Es 695 Es 696 Es 697 Es 698 Es 699 Es 700 Es 701 Es 702 Es 703 Es 704 Es 705 Es 706 Es 707 Es 708 Es 709 Es 710 Es 711 Es 712 Es 713 Es 714 Es 715 Es 716 Es 717 Es 718 Es 719 Es 720 Es 721 Es 722 Es 723 Es 724 Es 725 Es 726 Es 727 Es 728 Es 729 Es 730 Es 731 Es 732 Es 733 Es 734 Es 735 Es 736 Es 737 Es 738 Es 739 Es 740 Es 741 Es 742 Es 743 Es 744 Es 745 Es 746 Es 747 Es 748 Es 749 Es 750 Es 751 Es 752 Es 753 Es 754 Es 755 Es 756 Es 757 Es 758 Es 759 Es 760 Es 761 Es 762 Es 763 Es 764 Es 765 Es 766 Es 767 Es 768 Es 769 Es 770 Es 771 Es 772 Es 773 Es 774 Es 775 Es 776 Es 777 Es 778 Es 779 Es 780 Es 781 Es 782 Es 783 Es 784 Es 785 Es 786 Es 787 Es 788 Es 789 Es 790 Es 791 Es 792 Es 793 Es 794 Es 795 Es 796 Es 797 Es 798 Es 799 Es 800 Es 801 Es 802 Es 803 Es 804 Es 805 Es 806 Es 807 Es 808 Es 809 Es 810 Es 811 Es 812 Es 813 Es 814 Es 815 Es 816 Es 817 Es 818 Es 819 Es 820 Es 821 Es 822 Es 823 Es 824 Es 825 Es 826 Es 827 Es 828 Es 829 Es 830 Es 831 Es 832 Es 833 Es 834 Es 835 Es 836 Es 837 Es 838 Es 839 Es 840 Es 841 Es 842 Es 843 Es 844 Es 845 Es 846 Es 847 Es 848 Es 849 Es 850 Es 851 Es 852 Es 853 Es 854 Es 855 Es 856 Es 857 Es 858 Es 859 Es 860 Es 861 Es 862 Es 863 Es 864 Es 865 Es 866 Es 867 Es 868 Es 869 Es 870 Es 871 Es 872 Es 873 Es 874 Es 875 Es 876 Es 877 Es 878 Es 879 Es 880 Es 881 Es 882 Es 883 Es 884 Es 885 Es 886 Es 887 Es 888 Es 889 Es 890 Es 891 Es 892 Es 893 Es 894 Es 895 Es 896 Es 897 Es 898 Es 899 Es 900 Es 901 Es 902 Es 903 Es 904 Es 905 Es 906 Es 907 Es 908 Es 909 Es 910 Es 911 Es 912 Es 913 Es 914 Es 915 Es 916 Es 917 Es 918 Es 919 Es 920 Es 921 Es 922 Es 923 Es 924 Es 925 Es 926 Es 927 Es 928 Es 929 Es 930 Es 931 Es 932 Es 933 Es 934 Es 935 Es 936 Es 937 Es 938 Es 939 Es 940 Es 941 Es 942 Es 943 Es 94				

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****Added 30 FR 15801**

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CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—continued

[See notes at end of appendix]

Element (atomic number)	Isotope	Table I			Table II		
		Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 3 Air ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 3 Air ($\mu\text{Ci/ml}$)
Phosphorus (15)	Pu 240	2X10 ⁻¹²	1X10 ⁻¹¹	6X10 ⁻¹⁴	5X10 ⁻¹⁴	3X10 ⁻¹³	4X10 ⁻¹³
	Pu 241	4X10 ⁻¹¹	8X10 ⁻¹¹	1X10 ⁻¹²	3X10 ⁻¹²	2X10 ⁻¹²	3X10 ⁻¹²
	Pu 242	4X10 ⁻¹¹	4X10 ⁻¹¹	1X10 ⁻¹²	1X10 ⁻¹²	1X10 ⁻¹²	1X10 ⁻¹²
	Pu 243	3X10 ⁻¹¹	1X10 ⁻¹¹	6X10 ⁻¹⁴	3X10 ⁻¹⁴	3X10 ⁻¹⁴	3X10 ⁻¹⁴
	Pu 244	2X10 ⁻¹¹	1X10 ⁻¹¹	6X10 ⁻¹⁴	3X10 ⁻¹⁴	3X10 ⁻¹⁴	3X10 ⁻¹⁴
Polonium (84)	Po 210	5X10 ⁻¹⁰	2X10 ⁻¹⁰	2X10 ⁻¹¹	7X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	K42	2X10 ⁻¹⁰	8X10 ⁻¹¹	7X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Pr 142	2X10 ⁻¹⁰	6X10 ⁻¹¹	4X10 ⁻¹¹	2X10 ⁻¹¹	2X10 ⁻¹¹	1X10 ⁻¹¹
	Pr 143	2X10 ⁻¹⁰	9X10 ⁻¹¹	5X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Pm 147	2X10 ⁻¹⁰	1X10 ⁻¹⁰	6X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
Protactinium (91)	Pa 231	1X10 ⁻¹⁰	3X10 ⁻¹⁰	3X10 ⁻¹¹	2X10 ⁻¹¹	2X10 ⁻¹¹	1X10 ⁻¹¹
	Pa 233	6X10 ⁻¹⁰	4X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Ra 223	2X10 ⁻¹⁰	3X10 ⁻¹⁰	6X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Ra 224	5X10 ⁻¹⁰	1X10 ⁻¹⁰	8X10 ⁻¹¹	4X10 ⁻¹¹	4X10 ⁻¹¹	1X10 ⁻¹¹
	Ra 226	7X10 ⁻¹⁰	2X10 ⁻¹⁰	2X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
Radium (86)	Rn 220	4X10 ⁻¹⁰	1X10 ⁻¹⁰	1X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Rn 222	1X10 ⁻¹⁰	3X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Re 183	3X10 ⁻¹⁰	8X10 ⁻¹⁰	9X10 ⁻¹¹	6X10 ⁻¹¹	6X10 ⁻¹¹	3X10 ⁻¹¹
	Re 186	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Re 187	3X10 ⁻¹⁰	4X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
Rhodium (45)	Rh 103m	2X10 ⁻¹⁰	9X10 ⁻¹¹	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Rh 105	3X10 ⁻¹⁰	8X10 ⁻¹⁰	9X10 ⁻¹¹	6X10 ⁻¹¹	6X10 ⁻¹¹	3X10 ⁻¹¹
	Rb 86	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Rb 87	3X10 ⁻¹⁰	4X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Ru 97	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
Ruthenium (44)	Ru 103	3X10 ⁻¹⁰	8X10 ⁻¹⁰	9X10 ⁻¹¹	6X10 ⁻¹¹	6X10 ⁻¹¹	3X10 ⁻¹¹
	Ru 105	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Ru 106	3X10 ⁻¹⁰	4X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Sm 147	3X10 ⁻¹⁰	2X10 ⁻¹⁰	1X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Sm 151	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
Samarium (62)	Sm 153	3X10 ⁻¹⁰	2X10 ⁻¹⁰	1X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Sm 154	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Sm 155	3X10 ⁻¹⁰	4X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Sm 156	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Sm 157	3X10 ⁻¹⁰	2X10 ⁻¹⁰	1X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹

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**Revised 30 FR 15801

*** Added 30 FR 15801

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—continued

[See notes at end of appendix]

Element (atomic number)	Isotope	Table I			Table II		
		Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 3 Air ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 3 Air ($\mu\text{Ci/ml}$)
Scandium (21)	Sc 46	2X10 ⁻¹²	1X10 ⁻¹¹	6X10 ⁻¹⁴	5X10 ⁻¹⁴	3X10 ⁻¹³	4X10 ⁻¹³
	Sc 47	4X10 ⁻¹¹	8X10 ⁻¹¹	1X10 ⁻¹²	3X10 ⁻¹²	2X10 ⁻¹²	3X10 ⁻¹²
	Sc 48	4X10 ⁻¹¹	4X10 ⁻¹¹	1X10 ⁻¹²	1X10 ⁻¹²	1X10 ⁻¹²	1X10 ⁻¹²
	Sc 49	3X10 ⁻¹¹	1X10 ⁻¹¹	6X10 ⁻¹⁴	3X10 ⁻¹⁴	3X10 ⁻¹⁴	3X10 ⁻¹⁴
	Sc 50	2X10 ⁻¹¹	1X10 ⁻¹¹	6X10 ⁻¹⁴	3X10 ⁻¹⁴	3X10 ⁻¹⁴	3X10 ⁻¹⁴
Selenium (34)	Se 75	5X10 ⁻¹⁰	2X10 ⁻¹⁰	2X10 ⁻¹¹	7X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Si 31	2X10 ⁻¹⁰	8X10 ⁻¹¹	7X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Ag 105	2X10 ⁻¹⁰	6X10 ⁻¹¹	4X10 ⁻¹¹	2X10 ⁻¹¹	2X10 ⁻¹¹	1X10 ⁻¹¹
	Ag 110m	2X10 ⁻¹⁰	9X10 ⁻¹¹	5X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Ag 111	2X10 ⁻¹⁰	6X10 ⁻¹¹	4X10 ⁻¹¹	2X10 ⁻¹¹	2X10 ⁻¹¹	1X10 ⁻¹¹
Sodium (11)	Na 22	2X10 ⁻¹⁰	1X10 ⁻¹⁰	6X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Na 24	1X10 ⁻¹⁰	3X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Sr 85m	1X10 ⁻¹⁰	4X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Sr 85	1X10 ⁻¹⁰	3X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Sr 89	1X10 ⁻¹⁰	3X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
Strontium (38)	Sr 90	1X10 ⁻¹⁰	3X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Sr 91	1X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Sr 92	1X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	S 35	3X10 ⁻¹⁰	2X10 ⁻¹⁰	1X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Ta 182	3X10 ⁻¹⁰	2X10 ⁻¹⁰	1X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
Technetium (43)	Tc 99m	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Tc 96	3X10 ⁻¹⁰	8X10 ⁻¹⁰	9X10 ⁻¹¹	6X10 ⁻¹¹	6X10 ⁻¹¹	3X10 ⁻¹¹
	Tc 97m	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Tc 97	3X10 ⁻¹⁰	4X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Tc 99	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
Tellurium (52)	Te 125m	3X10 ⁻¹⁰	8X10 ⁻¹⁰	9X10 ⁻¹¹	6X10 ⁻¹¹	6X10 ⁻¹¹	3X10 ⁻¹¹
	Te 127m	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Te 127	3X10 ⁻¹⁰	4X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Te 129m	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Te 129	3X10 ⁻¹⁰	8X10 ⁻¹⁰	9X10 ⁻¹¹	6X10 ⁻¹¹	6X10 ⁻¹¹	3X10 ⁻¹¹
Terbium (65)	Th 160	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Th 161	3X10 ⁻¹⁰	8X10 ⁻¹⁰	9X10 ⁻¹¹	6X10 ⁻¹¹	6X10 ⁻¹¹	3X10 ⁻¹¹
	Th 162	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Th 163	3X10 ⁻¹⁰	4X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Th 164	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
Thallium (81)	Tl 200	3X10 ⁻¹⁰	2X10 ⁻¹⁰	1X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹
	Tl 201	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Tl 202	3X10 ⁻¹⁰	4X10 ⁻¹⁰	2X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Tl 203	3X10 ⁻¹⁰	1X10 ⁻¹⁰	3X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹	1X10 ⁻¹¹
	Tl 204	3X10 ⁻¹⁰	2X10 ⁻¹⁰	1X10 ⁻¹¹	3X10 ⁻¹¹	3X10 ⁻¹¹	1X10 ⁻¹¹

[See notes at end of appendix]

* added 30 Feb 15501

[See notes at end of appendix]

Any single radiorecitable unit listed above with decay mode other than alpha emission or spontaneous fission and with radiorecitable half-life greater than 3 hours.	Any single radiorecitable unit listed above with decay mode other than alpha emission or spontaneous fission and with radiorecitable half-life greater than 3 hours.	Any single radiorecitable unit listed above, which decays by alpha emission or spontaneous fission.
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* ¹ Soluble (S); Insoluble (I).

* "Sub" means that values given are for submersion in a semispherical infinite cloud of airborne 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:

- For purposes of Table I, Col. 1— 6×10^{-12}
- For purposes of Table I, Col. 2— 4×10^{-7}
- For purposes of Table II, Col. 1— 2×10^{-14}
- For purposes of Table II, Col. 2— 3×10^{-8}

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

4. If the mixture of radionuclides consists of uranium and its daughter products in ore dust prior to chemical processing of the uranium ore, the values specified below may be used in lieu of those determined in accordance with paragraph 1 above or those specified in paragraphs 2 and 3 above.

a. For purposes of Table I, Col. 1— 1×10^{-10} μ Ci/ml gross alpha activity; or 2.5×10^{-11} μ Ci/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1— 3×10^{-12} μ Ci/ml gross alpha activity; or 8×10^{-13} μ Ci/ml natural uranium; or 3 micrograms per cubic meter of air natural uranium.

5. For purposes of this Note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_A) to the concentration limit for that radionuclide specified in Table II of Appendix "B" (MPC_A) does not exceed $\frac{1}{10}$, (i.e., $\frac{C_A}{MPC_A} \leq \frac{1}{10}$) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed $\frac{1}{4}$ i.e.,

$$\frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \dots \leq \frac{1}{4}$$

c. Element (atomic number) and isotope	Table I		Table II	
	Column 1 Air (μ Ci/ml)	Column 2 Water (μ Ci/ml)	Column 1 Air (μ Ci/ml)	Column 2 Water (μ Ci/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131, (I 133, table II only), Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 256 are not present.		9×10^{-4}		3×10^{-4}
If it is known that Sr 90, I 125, I 126, I 129, (I 131, I 133, table II only), Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 256 are not present.		6×10^{-4}		2×10^{-4}
If it is known that Sr 90, I 129, (I 125, I 126, I 131, table II only), Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present.		2×10^{-4}		6×10^{-4}
If it is known that (I 129, table II only), Ra 226, and Ra 228 are not present.		3×10^{-4}		1×10^{-4}
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 240, and Bk 249 are not present.	3×10^{-4}		1×10^{-8}	
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present.	3×10^{-8}		1×10^{-11}	
If it is known that alpha-emitters and Ac 227 are not present.	3×10^{-11}		1×10^{-8}	
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 244, Cm 248, Cf 249 and Cf 251 are not present.	3×10^{-12}		1×10^{-8}	

*Revised 30 FR 15801

**ERRATUM: This line should read:

"210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not"

Appendix B from 25 FR 10914 except as otherwise noted.

PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

APPENDIX C

Material	Micro-curies
Ag ¹⁰⁸	1
Ag ¹¹⁰	10
As ⁷⁵ , As ⁷⁷	10
Au ¹⁹⁸	10
Au ¹⁹⁹	10
Ba ¹³⁰ + La ¹⁴⁰	1
Be ¹⁰	1
C ¹⁴	50
C ¹⁵	50
Cd ¹⁰⁹	10
Cd ¹¹⁵ + Ag ¹⁰⁸	10
Co ⁶⁰ + Pr ¹⁴⁰	1
Cr ⁵¹	1
Co ⁶⁰	1
Cs ¹³⁷	50
Cs ¹³⁷ + Ba ¹³⁰	1
Cu ⁶⁴	50
Eu ¹⁵⁴	1
Fe ⁵⁹	50
Fe ⁵⁵	50
Ge ⁷⁶	1
Ge ⁷⁷	10
Ge ⁷⁸	50
H ³ (HTO or H ² O)	250
I ¹³¹	10
I ¹²⁵	1
I ¹²⁷	10
K ⁴⁰	10
La ¹⁴⁰	10
Mn ⁵⁶	1
Mn ⁵⁵	50
Mo ⁹⁹	10
Na ²⁴	10
Na ²²	10
Nh ¹³³	10
Ni ⁶³	1
Ni ⁶⁴	1
Pb ²¹⁰	10
Pd ¹⁰³ + Rh ¹⁰⁶	50
Pd ¹⁰⁹	10
Pm ¹⁴⁷	10
Po ²¹⁰	0.1
Pr ¹⁴⁰	10
Pu ²³⁹	1
Ra ²²⁶	0.1
Rb ⁸⁶	10
Re ¹⁸⁷	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 ⁹⁰	1
Sr ⁹⁰ + Y ⁹⁰	0.1
Ta ¹⁸²	10
Tc ⁹⁹	1
Tc ^{99m}	1
Tc ⁹⁹	10
Te ¹³⁰	1
Th (natural)	50
Ti ⁶⁴	50
Tritium. See H ³	250
U (natural)	50
U ²³⁵	1
U ²³⁵ - U ²³⁸	50
V ⁵¹	1
W ¹⁸⁷	10
Y ⁹⁰	1
Y ⁹¹	1
Zn ⁶⁵	10
Unidentified radioactive materials or any of the above in unknown mixtures	0.1

APPENDIX D

UNITED STATES ATOMIC ENERGY COMMISSION
COMPLIANCE OFFICES

Region	Address	Telephone	
		Daytime	Nights and holidays
I Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.	Region I, Division of Compliance, USAEC, 876 Hudson St., New York, N.Y., 10014.	212-689-1000	212-689-1000
II Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Panama Canal Zone, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia.	Region II, Division of Compliance, USAEC, 80 7th St. N.E., Atlanta, Ga., 30322.	404-526-5791	404-526-5791
III Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.	Region III, Division of Compliance, USAEC, Suite 410, Oakbrook Professional Bldg., Oak Brook, Ill., 60521.	312-654-1000	312-730-7711
IV Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming.	Region IV, Division of Compliance, USAEC, 1000 West Colfax Ave., Denver, Colo., 80215.	303-297-4211	303-297-5095
V Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington and U.S. territories and possessions in the Pacific.	Region V, Division of Compliance, USAEC, 2111 Bancroft Way, Berkeley, Calif., 94704.	415-841-5820	415-841-5820

31 FR 4668

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.

Appendix C from 25 FR 10914.

Appendix D from 27 FR 10826.

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 Au¹⁹⁸ and 25,000 μC of C¹⁴, it may also include not more than 3,000 μC of I¹³¹. This limit was determined as follows:

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

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.

April 5, 1966