



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

January 13, 1993

The Honorable Paul E. Gillmor
Member, United States
House of Representatives
120 Jefferson Street, 2nd Floor
Port Clinton, OH 43452

Dear Congressman Gillmor:

I am responding to your December 3, 1992, letter to Mr. Dennis Rathbun, Director of Congressional Affairs, pertaining to correspondence from Mr. Ralph L. Harding to the Secretary of the Army. Mr. Harding raised several concerns about the Army Reserve unit based in Bryan, Ohio. One of these concerns rega ded a "Danger Radioactive Material Stored Inside," sign posted on the outside of the building. The Nuclear Regulatory Commission's regulations regarding posting of facilities containing radioactive material are contained in 10 CFR 20.203, entitled, "Caution Signs, Labels, Signals and Controls" (see Enclosure 1).

By reviewing our files and contacting the Department of the Army, the NRC staff determined that the Army Reserve Unit based in Bryan, Ohio, only possesses self-luminous devices such as compasses or watches, and chemical agent detectors.

These devices, although containing small quantities of radioactive material, give off no penetrating radiation, pose no threat to individuals in the vicinity of the building and do not require the Army Reserve Unit to post the outside of their facility to comply with NRC regulations. Army personnel have informed NRC staff that currently the radioactive material sign has been removed from outside of the building. Similar self-luminous watches and compasses are available to the general public. The chemical agent detector functions similarly to a commercial smoke detector. Enclosed for your information are

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PDR PR
20 MISC PDR

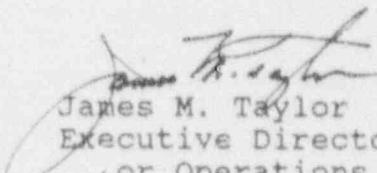
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device registration sheets for a typical self-luminous compass (see Enclosure 2) and a chemical agent detector (see Enclosure 3).

I trust that this reply will respond to your constituent's concerns.

Sincerely,


James M. Taylor
Executive Director
for Operations

Enclosures:

1. 10 CFR Part 20
2. Registry No. NR-210-D-101-E
3. Registry No. NR-155-D-118-S

UNITED STATES NUCLEAR REGULATORY COMMISSION

RULES and REGULATIONS

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Authority: Secs. 53, 63, 65, 81, 107, 104, 161, 162, 166, 68 Stat. 930, 933, 935, 936, 937, 948, 953, 955, as amended (42 U.S.C. 2073, 2093, 2093, 2111, 2133, 2134, 2201, 2232, 2236); Secs. 201, as amended, 202, 206, 68 Stat. 1242, as amended, 1244, 1246 (U.S.C. 5841, 5842, 5846).
Section 20.408 also issued under Secs. 193, 141, Pub. L. 97-425, 96 Stat. 2232, 2241 (42 U.S.C. 10157, 10161).

For the purposes of sec. 233, 68 Stat. 958, as amended (42 U.S.C. 2273), §§ 20.101, 20.102, 20.103 (a), (b), and (f), 20.104 (a) and (b), 20.105 (b), 20.106 (a), 20.201, 20.202 (a), 20.203, 20.207, 20.301, 20.303, 20.304, 20.305, 20.1102, 20.1201-20.1204, 20.1206, 20.1207, 20.1208, 20.1301, 20.1302, 20.1501, 20.1502, 20.1601 (a) and (b), 20.1602, 20.1603, 20.1701, 20.1704, 20.1801, 20.1802, 20.1901 (a), 20.1902, 20.1904, 20.1906, 20.2001, 20.2002, 20.2003, 20.2004, 20.2005 (b) and (c), 20.2006, 20.2101-20.2110, 20.2201-20.2206 and 20.2301 are issued under sec. 161b, 68 Stat. 948, as amended (42 U.S.C. 2201 (b)); § 20.2106 (d) is issued under the Privacy Act of 1974, Pub. L. 93-579, 5 U.S.C. 552a, and §§ 20.102, 20.103 (e), 20.401-20.407, 20.408 (b), 20.409, 20.1102 (a) (2) and (4), 20.1204 (c), 20.1206 (g) and (h), 20.1904 (c) (4), 20.1905 (c) and (d), 20.2005 (c), 20.2006 (b) (d), 20.2101-20.2103, 20.2104 (b) (4), 20.2105-20.2108, and 20.2201-20.2207 are issued under sec. 151b, 68 Stat. 950, as amended (42 U.S.C. 2201 (e)).

GENERAL PROVISIONS

§ 20.1 Purpose.

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

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

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

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

§ 20.2 Scope.

The regulations in this part apply to all persons who receive, possess, use, or transfer material licensed pursuant to the regulations in Parts 30 through 35, 36, 40, 60, 61, 70, or 72 of this chapter, including persons licensed to operate a production or utilization facility pursuant to Part 30 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 not less than 12 consecutive weeks nor more than 14 consecutive weeks. The first calendar quarter of each year shall begin in January and subsequent calendar quarters shall be such that no day is included in more than one calendar quarter or omitted from inclusion within a calendar quarter. No licensee shall change the method observed by him of determining calendar quarters except at the beginning of a calendar year.

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

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

(7) "Individual" means any human being;

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

(9) "License" means a license issued under the regulations in Parts 30 through 35, 39, 40, 60, 61, 70, or Part 72 of this chapter. "Licensee" means the holder of such license;

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

(11) "Person" means: (i) Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission or the Department (except that the Department shall be considered a person within the meaning of the regulations in this part to the extent that its facilities and activities are subject to the licensing and related regulatory authority of the Commission pursuant to section 262 of the Energy Reorganization Act of 1974 (88 Stat. 1244)), any State, any foreign government or nation or any political subdivision of any such government or nation, or other entity; and (ii) any legal successor, representative, agent, or agency of the foregoing.

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

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

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

(15) "Source material" means: (i) Uranium or thorium, or any combination thereof, in any physical or chemical form; or (ii) ores which contain by weight one-twentieth of one percent

(0.05%) or more of (a) uranium, (b) thorium or (c) any combination thereof. Source material does not include special nuclear material.

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

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

(18) "Department" means the Department of Energy established by the Department of Energy Organization Act (Pub. L. 95-91, 91 Stat. 565, 42 U.S.C. 7101 *et seq.*) to the extent that the Department, or its duly authorized representatives, exercises functions formerly vested in the U.S. Atomic Energy Commission, its Chairman, members, officers and components and transferred to the U.S. Energy Research and Development Administration and to the Administrator thereof pursuant to sections 104 (b), (c) and (d) of the Energy Reorganization Act of 1974 (Pub. L. 93-438, 88 Stat. 1233 at 1237, 42 U.S.C. 5814) and retransferred to the Secretary of Energy pursuant to section 301(a) of the Department of Energy Organization Act (Pub. L. 95-91, 91 Stat. 565 at 577-578, 42 U.S.C. 7151).

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

(20) "Dosimetry processor" means an individual or an organization that processes and evaluates personnel monitoring equipment in order to determine the radiation dose delivered to the equipment.

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

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

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

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

(4) "Survey" defined in § 20.201;

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

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

§ 20.4 Units of radiation dose.

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

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

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

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

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

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

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

NEUTRON FLUX DOSE EQUIVALENTS

Neutron energy (MeV)	Number of neutrons per square centimeter from 0.01 to 2 MeV (neutrons/cm ²)	Average biological effect in 4 hours (neutrons/cm ² sec.)
Thermal	870 × 10 ⁴	6
0.001	720 × 10 ⁴	5
0.005	620 × 10 ⁴	5
0.02	490 × 10 ⁴	2
0.1	120 × 10 ⁴	1
0.5	43 × 10 ⁴	1
1.0	26 × 10 ⁴	1
2.5	29 × 10 ⁴	2
5.0	26 × 10 ⁴	1
7.5	24 × 10 ⁴	1
10	24 × 10 ⁴	1
10 to 30	14 × 10 ⁴	1

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

§ 20.5 Units of radioactivity.

(a) Radioactivity is commonly, and for purposes of the regulations in this part shall be, measured in terms of disintegrations per unit time or in curies. One curie=3.7×10¹⁰ disintegrations per second (dps)=2.2×10¹¹ disintegrations per minute (dpm). Commonly used submultiples of the curie are the millicurie and the microcurie:

(1) One millicurie (mCi) =0.001 curie (Ci) =3.7×10⁷ dps.

(2) One microcurie (μCi) =0.000001 curie=3.7×10⁴ dps.

(b) (Deleted 40 FR 50704.)

(c) (Deleted 39 FR 23990.)

§ 20.6 Interpretations.

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

§ 20.7 Communications.

Except where otherwise specified in this part, all communications and reports concerning the regulations in this part should be addressed to the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, DC 20535. Communications, reports, and applications may be delivered in person at the Commission's offices at 2120 L Street NW, Washington, DC, or at 11555 Rockville Pike, Rockville, Maryland.

§ 20.102 Information collection requirements: OMB approval.

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

(b) The approved information collection requirements contained in this part appear in §§ 20.102, 20.103, 20.106, 20.108, 20.203, 20.205, 20.302, 20.311, 20.401, 20.402, 20.403, 20.405, 20.407, 20.408, and 20.409.

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

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

(2) In § 20.401, Form NRC-5 is approved under control number 3150-0006.

PERMISSIBLE DOSES, LEVELS, AND CONCENTRATIONS

§ 20.101 Radiation dose standards for individuals in restricted areas.

(a) In accordance with the provisions of § 20.102(a), and except as provided in paragraph (b) of this section, no licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from radioactive material and other sources of radiation a total occupational dose in excess of the standards specified in the following table:

REMS PER CALENDAR QUARTER

1. Whole body, head and trunk, active blood-forming organs, lens of eyes, or gonads.....	15
2. Hands and forearms, feet and ankles.....	15
3. Skin of whole body.....	75

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

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

(2) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall

not exceed 5 (N-18) rems where "N" equals the individual's age in years at his last birthday; and

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

§ 20.102 Determination of prior dose.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

For radon-222, the limiting quantity is that inhaled in a period of one calendar year. For radioactive materials designated "Sub" in the "Isotope" column of the table, the concentration value specified is based

upon exposure to the material as an external radiation source. Individual exposures to these materials may be accounted for as part of the limitation on individual dose in § 20.101. These nuclides shall be subject to the precautionary procedures required by § 20.103(b)(1).

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

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

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

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

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

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

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

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

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

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

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

(g) The licensee shall notify, in writing, the Regional Administrator

of the appropriate Nuclear Regulatory Commission Regional Office listed in Appendix D at least 30 days before the date that respiratory protective equipment is first used under the provisions of this section.

§ 20.104 Exposure of minors.

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

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

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

§ 20.105 Permissible levels of radiation in unrestricted areas.

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

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

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

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

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

§ 20.106 Radioactivity in effluents to unrestricted areas.

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

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

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

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

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

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

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

(i) Chemical composition;

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

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

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

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

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

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

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

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

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

centrations of radionuclides.

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

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

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

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

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

§ 20.107 Medical diagnosis and therapy.

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

§ 20.108 Orders requiring furnishing of bio-assay services.

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

PRECAUTIONARY PROCEDURES

§ 20.201 Surveys.

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

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

§ 20.202 Personnel monitoring.

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

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

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

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

(b) As used in this part,

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

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

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

(c) All personnel dosimeters [except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to hands and forearms, feet and ankles] that require processing to determine the radiation dose and that are utilized by licensees to comply with paragraph (a) of this section, with other applicable provisions of 10 CFR Chapter I, or with conditions specified in a licensee's license must be processed and evaluated by a dosimetry processor.

(1) Holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Bureau of Standards, and

(2) Approved in this accreditation process for the type of radiation or radiations included in the NVLAP program that most closely approximate the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

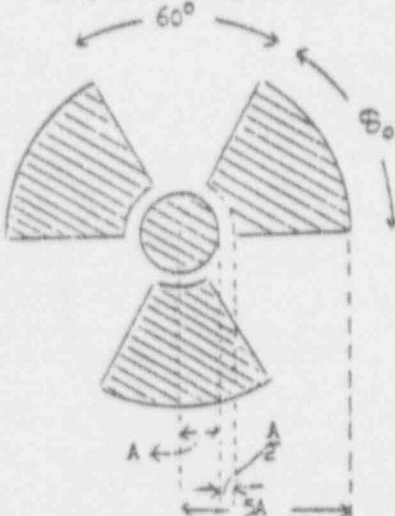
Note: (c) effective 2/12/88

§ 20.203 Caution signs, labels, signals and controls.

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

RADIATION SYMBOL

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



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

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

CAUTION RADIATION AREA

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

CAUTION HIGH RADIATION AREA

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

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

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

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

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

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

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

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

Or "Danger".

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

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

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

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

sources in non-self-shielded irradiators

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

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prise permanent structural components, such as walls, that have no credible probability of failure or removal in ordinary circumstances need not meet the requirements of this paragraph (c)(6)(iii).

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

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

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

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

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

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

(d) Airborne radioactivity areas. (1) As used in the regulations in this part "airborne radioactivity area" means (i) any room, enclosure, or operating area in which airborne radioactive materials composed wholly or partly of licensed material, exist in concentrations in excess of the amounts specified in Appendix B, Table 1, 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 1, Column 1 of this part.

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

CAUTION

AIRBORNE RADIOACTIVITY AREA

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

Or "Danger."

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

CAUTION

RADIOACTIVE MATERIAL(S)

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

CAUTION

RADIOACTIVE MATERIAL(S)

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

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

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

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

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

(iii) For containers that do not contain licensed materials in concentrations greater than the applicable concentrations listed in Appendix B, Table 1, Column 2, of this part.

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

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

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

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

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

§ 20.204 Same exceptions.

Notwithstanding the provisions of § 20.203.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

TABLE OF EXEMPT AND TYPE A QUANTITIES

Transport group	Exempt quantity limit (in millicuries)	Type A quantity limit (in curies)
I	0.1	0.001
II	0.1	0.050
III	1	3
IV	1	20
V	1	20
VI	1	1000
VII	25,000	1000
Special Form	1	20

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

[Footnote 1 removed 49 FR 19623]

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

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

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

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

§ 20.206 Instruction of personnel.

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

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

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

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

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

WASTE DISPOSAL

§ 20.301 General requirement.

No licensee shall dispose of licensed material except:

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

(b) As authorized under § 20.302 or Part 61 of this chapter; or

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

§ 20.302 Method for obtaining approval of proposed disposal procedures.

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

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

§ 20.303 Disposal by release into sanitary sewerage systems.

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

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

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

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

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

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

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

§ 20.305 Treatment or disposal by incineration.

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

§ 20.306 Disposal of specific wastes.

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

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

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

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

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

§ 20.311 Transfer for disposal and manifests.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

equivalent documentation by the collector;

(7) Include the new manifest with the shipment;

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

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

(g) The land disposal facility operator shall:

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

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

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

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

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

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

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 NRC-5, in accordance with the instructions contained in that form or on clear and legible records containing all the information required by Form NRC-5. The doses entered on the forms or records shall be for periods of time not exceeding one calendar quarter.

(b) Each licensee shall maintain records in the same units used in this part, showing the results of surveys required by § 20.201(b), monitoring required by §§ 20.205(b) and 20.205(c), and disposals made under §§ 20.302, 20.303, removed § 20.304,¹ and Part 61 of this chapter.

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

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

¹Section 20.304 provided for burial of small quantities of licensed materials in soil. Notice of its removal appears in the FEDERAL REGISTER of October 30, 1980 (45 FR 71762).

²See footnote 1 to paragraph (b) of this section.

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

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

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

§ 20.402 Reports of theft or loss of licensed material.

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

(2) Reports must be made as follows:

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

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

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

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

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

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

(4) Radiation exposures to individ-

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

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

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

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

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

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

§ 20.403 Notifications of incidents.

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

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

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

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

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

(b) Twenty-four hour notification.

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

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

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

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

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

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

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

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

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

§ 20.404 (Reserved)

§ 20.405 Reports of overexposures and excessive levels and concentrations.

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

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

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

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

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

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

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

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

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

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

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

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

(c)(1) In addition to any notification required by § 20.403 of this part, each licensee shall make a report in writing of levels of radiation or releases of radioactive material in excess of limits specified by 40 CFR Part 190.

"Environmental Radiation Protection Standards for Nuclear Power Operations," or in excess of license conditions related to compliance with 40 CFR Part 190.

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

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

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

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

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

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

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

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

§ 20.406 [Reserved]

§ 20.407 Personnel monitoring reports.

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

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

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

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

year was in each of the following estimated exposure ranges:

Estimated whole body exposure range (rem)	Number of individuals in each range
Not measurable exposure	
Measurable exposure less than 0.1	
0.1 to 0.25	
0.25 to 0.5	
0.5 to 0.75	
0.75 to 1	
1 to 2	
2 to 3	
3 to 4	
4 to 5	
5 to 6	
6 to 7	
7 to 8	
8 to 9	
9 to 10	
10 to 11	
11 to 12	
12+	

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

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

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

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

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

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

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

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

(5) Possess spent fuel in an independent spent fuel storage installation (ISFSI) or possess spent fuel or high level radioactive waste in a monitored retrievable storage installation (MRS) pursuant to Part 72 of this chapter; or

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

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

The Commission may require, as a license condition or by rule, regulation or order pursuant to § 20.502, reports from licensees who are licensed to use radionuclides not on this list in quantities sufficient to cause comparable radiation levels.

§ 20.409 Notifications and reports to individuals.

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

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

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

(b) When an individual terminates employment with a licensee described in paragraph (a) of this section, or an individual assigned to work in such a licensee's facility, but not employed by the licensee, completes the work assignment in the licensee's facility, the licensee shall furnish to the REIRS Project Manager, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555, a report of the individual's exposures to radiation and radioactive material, incurred during the period of employment or work assignment in the licensee's facility, containing information recorded by the licensee pursuant to §§ 20.401(a) and 20.108. Such report shall be furnished within 30 days after the exposure of the individual has been determined by the licensee or 90 days after the date of termination of employment or work assignment, whichever is earlier.

EXCEPTIONS AND ADDITIONAL REQUIREMENTS

§ 20.501 Applications for exemptions.

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

§ 20.502 Additional requirements.

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

ENFORCEMENT

§ 20.601 Violations.

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

[Note removed 49 FR 19623]

PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

Appendix A to §20.1-20.601—Protection Factors for Respirators

Description ¹	Mode ¹	Protection factors ²		Notes and certified equipment—National Institute for Occupational Safety and Health (NIOSH) and Health, Safety and Health Administration tests for permeability
		PC suit ³ (%)	Perforation, grams and cubic ft	
1. Air-purifying respirators ⁴				
Facepiece, full-mask ⁵	MF	10		30 CFR Part 11, Subpart K.
Facepiece, full	MF	50		
Facepiece, half-mask, full, or hood	MF	1,000		
2. Atmosphere-supplying respirators				
1. A-line respirator				
Facepiece, full-mask	CF		1,000	
Facepiece, full-mask	D		5	
Facepiece, full	CF		5,000	
Facepiece, full	D		5	30 CFR Part 11, Subpart J.
Facepiece, full	PD		5,000	
Hood	CF		(F)	
Suit	CF		(F)	
2. Self-contained breathing apparatus (SCBA)				
Facepiece, full	D		80	
Facepiece, full	PD		10,000	30 CFR Part 11, Subpart H.
Facepiece, full	PD		80	
Facepiece, full	MF		1,000	
3. Combination respirator ⁶ for combination of air-purifying and atmosphere-supplying respirators.				30 CFR Part 11, § 11.83(b).

¹ For use in the selection of respirator protective devices to be used only where the contaminants have been identified and the concentrations or possible concentrations are known.

² Only for steady-state and where nothing interferes with the seal of respirator components against the skin. Hoods and suits are excluded.

³ The mode symbols are defined as follows: CF = continuous flow; D = demand; MF = negative pressure; PD = positive pressure; (F) = negative pressure during exhalation; PD = pressure demand (i.e., always positive pressure); MF = positive pressure; PD = demand; MF = negative pressure; (F) = negative pressure during exhalation; PD = pressure demand (i.e., always positive pressure).

⁴ The protection factor is a measure of the degree of protection afforded by a respirator against the rate of the concentration of airborne radioactive material outside the respiratory protective equipment to that inside the equipment (usually inside the facepiece) under conditions of use. It is equal to the ambient airborne concentration to estimate the concentration inside the equipment according to the following formula:

Concentration inside = Ambient airborne concentration / Protection factor

⁵ The protection factor is based on:

- For air-purifying respirators only when high efficiency particulate filters (above 99.97% removal efficiency by thermally generated 0.3 µm dusty aerosols (DOP) test) are used in atmosphere not deficient in oxygen and not containing radioactive gas or vapor respiratory hazards.
- No allowance is to be made for the use of cartridges against radioactive gases or vapors.
- For atmosphere-supplying respirators only when supplied with adequate respirable air. Respirable air shall be provided of the quality and quantity required in accordance with NIOSH/MSHA certification (issued in 30 CFR Part 11). Oxygen and air shall not be used in the same apparatus.

⁶ Excluding radioactive contaminants that present an absorption or submersion hazard. For inhalation hazard, appropriate use of the mask occurs by absorption through the skin so that an overall protection factor of less than 2 is appropriate when atmosphere-supplying respirators are used to protect against inhalation hazard. If the protection factor for a device is 5, the effective protection factor for inhalation is about 1.4; for devices with protection factors of 10 the effective factor for inhalation is about 1.3; for air-purifying respirators not suitable for protection against inhalation hazard, the effective factor for inhalation is about 1.2. For skin and eye protection, the effective factor for skin and eye is about 1.2. For skin and eye protection, the effective factor for skin and eye is about 1.2.

⁷ Cartridges and canisters shall not be used beyond service-life limitations.

⁸ Under one type only. This type of respirator is not satisfactory for use where it might be possible to e.g., if an accident or emergency were to occur for the ambient airborne concentration to reach instantaneous values greater than 10 times the pertinent values in Table 1, Column 1 of Appendix B of this part. This type of respirator is not suitable for protection against plutonium or other high-activity materials. The mask shall be tested by NIOSH with each type and maintained.

⁹ The equipment shall be covered in a manner that ensures that proper air flow is maintained and unobstructed airway pressure gauges or flow measuring devices are used. A protection factor of no more than 1000 may be used for tested and certified supplied-air hoods when a minimum air flow of 4 cubic feet per minute is maintained and unobstructed airway pressure gauges or flow measuring devices are used. A protection factor of up to 2000 may be used for tested and certified supplied-air hoods when the air flow is maintained and the manufacturer's recommended maximum rate for the equipment, this rate is greater than 4 cubic feet per minute.

¹⁰ The design of the supplied-air hood or helmet with a minimum flow of 4 gpm of air may determine its overall efficiency and the protection it provides. For example, some hoods aspirate contaminated air into the breathing zone when the wearer works with hands-over-head. This aspiration may be overcome if a short cap-like extension to the hood is worn under a coat or under conditions of use.

¹¹ Appropriate protection factors shall be determined based on 20100dCi, taking into account the design of the suit and its permeability to the contaminants under conditions of use. There shall be a standby rescue person equipped with self-contained breathing apparatus and communications equipment whenever supplied-air suits are used.

¹² No approval certificates are currently available for the equipment. Equipment shall be evaluated by testing or on the basis of relevant test information.

¹³ This type of respirator may provide greater protection and be used as an emergency device in uranium concentrations for protection against inhalation hazards. External radiation hazards and other exposures to personnel exposed to such situations shall be taken into account in these circumstances.

¹⁴ Clearance is testing shall be performed on each individual and no more than 0.5% leakage is allowed with this type of apparatus. Permissible outward leakage of gas from this or any positive pressure self-contained breathing apparatus is unacceptable because service life will be reduced substantially. Special training in the use of this type of apparatus shall be provided to the wearer (see footnote 1).

¹⁵ Protection factor for type and mode of use as listed above.

Note 1.—Protection factors for respirators, as may be approved by the U.S. Bureau of Mines/National Institute for Occupational Safety and Health (NIOSH) according to applicable approvals for respirators for type and mode of use to protect against airborne radionuclides, may be used to the extent that they do not exceed the protection factors listed in this table. The protection factors listed in this table may not be appropriate to circumstances where chemical or other respiratory hazards exist in addition to radiological hazards. The selection and use of respirators for these circumstances should take into account applicable approvals of the U.S. Bureau of Mines/NIOSH.

Note 2.—Radioactive contaminants for which the concentration values in Table 1, column 1, Appendix B of this part are based on internal dose due to inhalation may, in addition, present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.

Appendix B to §§20.1-20.601 —
Concentrations in Air and Water Above Natural Background

[See notes at end of appendix]

Element (atomic number)	Isotope	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air + (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Actinium (89)	Ac 227	5	2×10^{-12}	6×10^{-13}	8×10^{-14}
		1	3×10^{-11}	9×10^{-13}	3×10^{-13}
	Ac 228	5	8×10^{-12}	3×10^{-12}	9×10^{-13}
		1	2×10^{-11}	3×10^{-12}	9×10^{-13}
Americium (95)	Am 241	5	6×10^{-11}	1×10^{-12}	2×10^{-12}
		1	1×10^{-10}	8×10^{-13}	4×10^{-13}
	Am 242m	5	6×10^{-11}	1×10^{-12}	2×10^{-12}
		1	2×10^{-10}	3×10^{-12}	4×10^{-13}
	Am 242	5	4×10^{-11}	4×10^{-12}	1×10^{-12}
		1	3×10^{-10}	4×10^{-12}	1×10^{-12}
	Am 243	5	6×10^{-12}	1×10^{-12}	2×10^{-12}
		1	1×10^{-10}	8×10^{-13}	4×10^{-13}
Antimony (51)	Sb 122	5	2×10^{-12}	8×10^{-13}	6×10^{-13}
		1	1×10^{-11}	8×10^{-13}	3×10^{-13}
	Sb 124	5	2×10^{-12}	7×10^{-13}	3×10^{-13}
		1	2×10^{-11}	7×10^{-13}	2×10^{-13}
	Sb 125	5	3×10^{-12}	3×10^{-13}	2×10^{-13}
		1	3×10^{-11}	3×10^{-13}	1×10^{-13}
				9×10^{-13}	1×10^{-13}
				1×10^{-12}	
Argon (18)	A 37	Sub?	6×10^{-13}		
	A 41	Sub	2×10^{-14}		
Arsenic (33)	As 73	5	2×10^{-12}	1×10^{-12}	7×10^{-13}
		1	4×10^{-12}	1×10^{-12}	5×10^{-13}
	As 74	5	2×10^{-12}	3×10^{-13}	1×10^{-12}
		1	1×10^{-11}	2×10^{-12}	3×10^{-13}
	As 76	5	1×10^{-12}	6×10^{-13}	4×10^{-13}
		1	1×10^{-11}	6×10^{-13}	2×10^{-13}
	As 77	5	5×10^{-12}	2×10^{-13}	2×10^{-13}
Astatine (85)	At 211	5	4×10^{-12}	2×10^{-13}	3×10^{-13}
		1	2×10^{-11}	5×10^{-13}	2×10^{-13}
				2×10^{-12}	2×10^{-13}
				1×10^{-12}	7×10^{-13}
Barium (56)	Ba 131	5	1×10^{-12}	3×10^{-13}	4×10^{-13}
		1	4×10^{-12}	3×10^{-13}	2×10^{-13}
	Ba 140	5	1×10^{-12}	8×10^{-13}	4×10^{-13}
Berkelium (97)	Bk 249	5	4×10^{-12}	7×10^{-13}	1×10^{-12}
		1	9×10^{-12}	2×10^{-12}	3×10^{-13}
	Bk 250	5	1×10^{-12}	3×10^{-13}	4×10^{-13}
Beryllium (4)	Be 7	5	1×10^{-12}	6×10^{-13}	5×10^{-13}
		1	6×10^{-12}	4×10^{-13}	3×10^{-13}
			1×10^{-11}	3×10^{-12}	2×10^{-13}
Bismuth (83)	Bi 206	5	5×10^{-12}	4×10^{-13}	2×10^{-13}
		1	2×10^{-11}	4×10^{-13}	2×10^{-13}
	Bi 207	5	1×10^{-12}	6×10^{-13}	4×10^{-13}
		1	2×10^{-11}	5×10^{-13}	4×10^{-13}
	Bi 210	5	1×10^{-12}	3×10^{-13}	4×10^{-13}
		1	6×10^{-12}	2×10^{-12}	4×10^{-13}
	Pb 212	5	1×10^{-12}	2×10^{-13}	4×10^{-13}
		1	1×10^{-11}	3×10^{-13}	4×10^{-13}
			2×10^{-11}	7×10^{-13}	4×10^{-13}

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

Element (atomic number)	Isotope	S	Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air $+ (\mu\text{Ci/ml})$	Water $(\mu\text{Ci/ml})$	Air $(\mu\text{Ci/ml})$	Water $(\mu\text{Ci/ml})$
Bromine (35)	Br 82	5	1×10^{-4}	6×10^{-7}	4×10^{-4}	3×10^{-4}
		1	2×10^{-7}	1×10^{-7}	6×10^{-4}	4×10^{-4}
Cadmium (48)	Cd 109	5	5×10^{-4}	5×10^{-7}	2×10^{-4}	2×10^{-4}
		1	7×10^{-4}	5×10^{-7}	3×10^{-4}	3×10^{-4}
	Cd 115m	5	4×10^{-4}	7×10^{-7}	1×10^{-4}	3×10^{-4}
		1	4×10^{-4}	7×10^{-7}	1×10^{-4}	3×10^{-4}
	Cd 115	5	2×10^{-4}	1×10^{-7}	6×10^{-4}	3×10^{-4}
		1	2×10^{-4}	1×10^{-7}	6×10^{-4}	4×10^{-4}
Calcium (20)	Ca 43	5	3×10^{-4}	3×10^{-7}	1×10^{-4}	9×10^{-4}
		1	1×10^{-4}	5×10^{-7}	4×10^{-4}	3×10^{-4}
	Ca 47	5	2×10^{-4}	1×10^{-7}	6×10^{-4}	5×10^{-4}
		1	2×10^{-4}	1×10^{-7}	6×10^{-4}	3×10^{-4}
Californium (98)	Cf 265	5	2×10^{-12}	1×10^{-4}	3×10^{-14}	4×10^{-4}
		1	1×10^{-12}	7×10^{-4}	3×10^{-12}	2×10^{-4}
	Cf 250	5	5×10^{-12}	4×10^{-4}	2×10^{-12}	1×10^{-4}
		1	1×10^{-12}	7×10^{-4}	3×10^{-12}	3×10^{-4}
	Cf 251	5	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-4}
		1	1×10^{-12}	8×10^{-4}	3×10^{-12}	3×10^{-4}
	Cf 252	5	6×10^{-12}	2×10^{-4}	2×10^{-12}	7×10^{-4}
		1	3×10^{-12}	2×10^{-4}	1×10^{-12}	2×10^{-4}
	Cf 253	5	8×10^{-12}	4×10^{-4}	3×10^{-12}	1×10^{-4}
		1	8×10^{-12}	4×10^{-4}	3×10^{-12}	1×10^{-4}
	Cf 254	5	3×10^{-12}	4×10^{-4}	2×10^{-12}	1×10^{-4}
		1	5×10^{-12}	4×10^{-4}	2×10^{-12}	1×10^{-4}
Carbon (6)	C 14	5	4×10^{-4}	2×10^{-7}	1×10^{-4}	8×10^{-4}
	(CO ₂)	Sub	5×10^{-4}		1×10^{-4}	
Cerium (58)	Ce 141	5	4×10^{-7}	4×10^{-3}	2×10^{-4}	9×10^{-4}
		1	2×10^{-7}	3×10^{-3}	5×10^{-4}	9×10^{-4}
	Ce 143	5	3×10^{-7}	1×10^{-3}	9×10^{-4}	4×10^{-4}
		1	2×10^{-7}	1×10^{-3}	7×10^{-4}	4×10^{-4}
	Ce 144	5	1×10^{-7}	3×10^{-4}	3×10^{-4}	1×10^{-4}
		1	6×10^{-7}	3×10^{-4}	2×10^{-4}	4×10^{-4}
Cesium (55)	Cs 131	5	1×10^{-7}	7×10^{-7}	4×10^{-7}	2×10^{-7}
		1	3×10^{-7}	3×10^{-7}	1×10^{-7}	9×10^{-7}
	Cs 134m	5	4×10^{-7}	2×10^{-7}	1×10^{-7}	6×10^{-7}
		1	6×10^{-7}	3×10^{-7}	2×10^{-7}	1×10^{-7}
	Cs 134	5	4×10^{-7}	3×10^{-7}	1×10^{-7}	9×10^{-7}
		1	1×10^{-7}	1×10^{-7}	4×10^{-7}	4×10^{-7}
	Cs 135	5	5×10^{-7}	3×10^{-7}	2×10^{-7}	1×10^{-7}
		1	9×10^{-7}	7×10^{-7}	3×10^{-7}	2×10^{-7}
	Cs 136	5	4×10^{-7}	2×10^{-7}	1×10^{-7}	9×10^{-7}
		1	3×10^{-7}	2×10^{-7}	6×10^{-7}	6×10^{-7}
	Cs 137	5	6×10^{-7}	4×10^{-7}	2×10^{-7}	2×10^{-7}
		1	1×10^{-7}	1×10^{-7}	5×10^{-7}	4×10^{-7}
Chlorine (17)	Cl 36	5	4×10^{-7}	2×10^{-7}	1×10^{-7}	8×10^{-7}
		1	2×10^{-7}	2×10^{-7}	8×10^{-7}	6×10^{-7}
	Cl 38	5	3×10^{-7}	1×10^{-7}	9×10^{-7}	4×10^{-7}
		1	2×10^{-7}	1×10^{-7}	7×10^{-7}	4×10^{-7}
Chromium (24)	Cr 51	5	1×10^{-7}	5×10^{-7}	4×10^{-7}	2×10^{-7}
		1	2×10^{-7}	3×10^{-7}	5×10^{-7}	3×10^{-7}

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

Element (atomic number)	Isotope	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air + (μCi/ml)(μCi/ml)		Air + (μCi/ml)(μCi/ml)	
Cesium (55)	Cs 137	5	3×10^{-4}	3×10^{-4}	1×10^{-4}
		1	2×10^{-4}	1×10^{-4}	4×10^{-4}
	Cs 134m	5	2×10^{-4}	8×10^{-4}	4×10^{-4}
		1	9×10^{-4}	6×10^{-4}	3×10^{-4}
	Cs 134	5	8×10^{-4}	4×10^{-4}	1×10^{-4}
		1	5×10^{-4}	3×10^{-4}	9×10^{-4}
Copper (29)	Cu 64	5	3×10^{-4}	1×10^{-4}	5×10^{-4}
		1	9×10^{-4}	1×10^{-4}	3×10^{-4}
Curium (96)	Cm 242	5	1×10^{-10}	7×10^{-11}	4×10^{-11}
		1	2×10^{-10}	6×10^{-11}	3×10^{-11}
	Cm 243	5	6×10^{-11}	1×10^{-11}	5×10^{-11}
		1	1×10^{-10}	7×10^{-11}	2×10^{-11}
	Cm 244	5	9×10^{-12}	2×10^{-12}	7×10^{-12}
		1	1×10^{-10}	3×10^{-12}	3×10^{-11}
	Cm 245	5	5×10^{-12}	1×10^{-11}	4×10^{-12}
		1	1×10^{-10}	8×10^{-12}	3×10^{-11}
	Cm 246	5	5×10^{-12}	1×10^{-11}	4×10^{-12}
		1	1×10^{-10}	6×10^{-12}	3×10^{-11}
	Cm 247	5	5×10^{-12}	1×10^{-11}	2×10^{-11}
		1	1×10^{-10}	6×10^{-12}	2×10^{-11}
	Cm 248	5	6×10^{-12}	1×10^{-11}	2×10^{-11}
		1	1×10^{-11}	4×10^{-12}	1×10^{-11}
Dysprosium (66)	Dy 165	5	3×10^{-4}	1×10^{-4}	9×10^{-4}
		1	2×10^{-4}	1×10^{-4}	4×10^{-4}
	Dy 166	5	2×10^{-4}	1×10^{-4}	8×10^{-4}
Einsteinium (99)		1	3×10^{-4}	1×10^{-4}	7×10^{-4}
	Es 252	5	8×10^{-10}	7×10^{-11}	3×10^{-11}
		1	6×10^{-10}	7×10^{-11}	2×10^{-11}
	Es 254m	5	5×10^{-4}	5×10^{-4}	3×10^{-4}
		1	6×10^{-4}	5×10^{-4}	2×10^{-4}
	Es 254	5	2×10^{-11}	4×10^{-11}	6×10^{-12}
Erbium (68)		1	1×10^{-10}	4×10^{-11}	1×10^{-11}
	Er 285	5	5×10^{-10}	8×10^{-11}	2×10^{-11}
		1	4×10^{-10}	8×10^{-11}	3×10^{-11}
	Er 169	5	6×10^{-4}	3×10^{-4}	2×10^{-4}
Europium (63)		1	4×10^{-4}	3×10^{-4}	1×10^{-4}
	Eu 171	5	7×10^{-4}	3×10^{-4}	2×10^{-4}
		1	6×10^{-4}	3×10^{-4}	1×10^{-4}
Euterium (62)	Eu 152	5	4×10^{-4}	2×10^{-4}	1×10^{-4}
	(T/2 = 9.2 hrs)	1	3×10^{-4}	2×10^{-4}	6×10^{-4}
	Eu 152	5	1×10^{-4}	3×10^{-4}	4×10^{-4}
	(T/2 = 13 yrs)	1	2×10^{-4}	2×10^{-4}	8×10^{-4}
	Eu 154	5	4×10^{-4}	6×10^{-4}	1×10^{-4}
		1	7×10^{-4}	6×10^{-4}	3×10^{-4}
	Eu 155	5	9×10^{-4}	4×10^{-4}	3×10^{-4}
		1	7×10^{-4}	6×10^{-4}	2×10^{-4}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air + (nCi/ml)(μCi/ml)		Water (μCi/ml)(μCi/ml)	
Fermium (100)	Fm 254	5	6×10^{-4}	4×10^{-3}	3×10^{-3}
		1	7×10^{-4}	4×10^{-3}	3×10^{-3}
	Fm 255	5	2×10^{-4}	1×10^{-3}	6×10^{-4}
		1	1×10^{-4}	1×10^{-3}	3×10^{-4}
Fluorine (9)	Fm 256	5	3×10^{-4}	3×10^{-3}	1×10^{-3}
		1	2×10^{-4}	3×10^{-3}	6×10^{-4}
	F 18	5	5×10^{-4}	2×10^{-3}	2×10^{-3}
		1	3×10^{-4}	1×10^{-3}	5×10^{-4}
Gadolinium (64)	Gd 152	5	2×10^{-4}	6×10^{-3}	3×10^{-3}
		1	9×10^{-4}	6×10^{-3}	3×10^{-3}
	Gd 155	5	5×10^{-4}	2×10^{-3}	2×10^{-3}
		1	4×10^{-4}	3×10^{-3}	8×10^{-4}
Gallium (31)	Ga 72	5	2×10^{-4}	1×10^{-3}	5×10^{-4}
		1	2×10^{-4}	1×10^{-3}	4×10^{-4}
Germanium (32)	Ge 71	5	1×10^{-4}	5×10^{-3}	6×10^{-4}
		1	6×10^{-4}	5×10^{-3}	4×10^{-4}
Gold (79)	Au 196	5	1×10^{-4}	5×10^{-3}	3×10^{-3}
		1	6×10^{-4}	4×10^{-3}	2×10^{-3}
	Au 198	5	3×10^{-4}	2×10^{-3}	1×10^{-3}
		1	2×10^{-4}	1×10^{-3}	5×10^{-4}
Hassium (78)	Hs 181	5	4×10^{-4}	4×10^{-3}	3×10^{-3}
		1	7×10^{-4}	3×10^{-3}	2×10^{-3}
Holmium (67)	Ho 164	5	3×10^{-4}	9×10^{-3}	7×10^{-3}
		1	3×10^{-4}	9×10^{-3}	7×10^{-3}
Hydrogen (1)	H3	5	5×10^{-4}	1×10^{-3}	2×10^{-3}
		1	5×10^{-4}	1×10^{-3}	3×10^{-3}
Indium (49)	Ind	Sub	2×10^{-4}	4×10^{-3}	3×10^{-3}
	In 113m	5	8×10^{-4}	4×10^{-3}	2×10^{-3}
		1	7×10^{-4}	4×10^{-3}	1×10^{-3}
	In 114m	5	1×10^{-4}	5×10^{-3}	4×10^{-3}
Iodine (53)		1	2×10^{-4}	5×10^{-3}	7×10^{-3}
	In 115m	5	2×10^{-4}	1×10^{-3}	6×10^{-3}
		1	2×10^{-4}	1×10^{-3}	4×10^{-3}
	In 115	5	3×10^{-4}	3×10^{-3}	9×10^{-3}
		1	3×10^{-4}	3×10^{-3}	9×10^{-3}
	I 125	5	5×10^{-4}	4×10^{-3}	2×10^{-3}
		1	2×10^{-4}	4×10^{-3}	2×10^{-3}
	I 126	5	8×10^{-4}	5×10^{-3}	3×10^{-3}
		1	3×10^{-4}	3×10^{-3}	3×10^{-3}
	I 129	5	3×10^{-4}	1×10^{-3}	9×10^{-3}
		1	7×10^{-4}	6×10^{-3}	6×10^{-3}
	I 131	5	9×10^{-4}	4×10^{-3}	2×10^{-3}
		1	3×10^{-4}	2×10^{-3}	3×10^{-3}
	I 137	5	2×10^{-4}	2×10^{-3}	4×10^{-3}
		1	6×10^{-4}	5×10^{-3}	2×10^{-3}
	I 133	5	3×10^{-4}	2×10^{-3}	4×10^{-3}
		1	2×10^{-4}	1×10^{-3}	7×10^{-3}
	I 134	5	3×10^{-4}	4×10^{-3}	6×10^{-3}
		1	3×10^{-4}	4×10^{-3}	3×10^{-3}

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APPENDIX B

Concentrations in Air and Water Above Natural Background — Continued

(See notes at end of appendix)

Element (atomic number)	Isotope	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air + (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Iodine (53)	I 134	1	3×10^{-12}	2×10^{-12}	1×10^{-12}
	I 135	5	1×10^{-12}	7×10^{-14}	1×10^{-14}
	I 137	1	4×10^{-12}	2×10^{-12}	1×10^{-12}
Iridium (77)	Ir 190	5	1×10^{-12}	6×10^{-13}	4×10^{-13}
	Ir 192	1	4×10^{-12}	5×10^{-13}	1×10^{-13}
	Ir 193	5	1×10^{-12}	1×10^{-12}	4×10^{-13}
Iron (26)	Fe 55	5	2×10^{-12}	1×10^{-12}	8×10^{-13}
	Fe 57	1	2×10^{-12}	9×10^{-14}	5×10^{-14}
	Fe 59	5	9×10^{-12}	3×10^{-12}	3×10^{-12}
Krypton (36)	Kr 85m	Sub	1×10^{-12}	3×10^{-13}	2×10^{-13}
	Kr 85	Sub	1×10^{-12}	3×10^{-13}	2×10^{-13}
	Kr 87	Sub	1×10^{-12}	2×10^{-13}	2×10^{-13}
Lanthanum (57)	La 140	5	2×10^{-12}	7×10^{-13}	5×10^{-13}
	La 141	1	1×10^{-12}	7×10^{-13}	4×10^{-13}
	La 142	5	2×10^{-12}	1×10^{-12}	9×10^{-13}
Lead (82)	Pb 203	5	2×10^{-12}	1×10^{-12}	9×10^{-13}
	Pb 204	1	2×10^{-12}	1×10^{-12}	6×10^{-13}
	Pb 205	5	1×10^{-12}	4×10^{-13}	4×10^{-13}
Lutetium (71)	Lu 177	5	2×10^{-12}	3×10^{-12}	2×10^{-12}
	Lu 178	1	2×10^{-12}	6×10^{-13}	6×10^{-13}
	Lu 179	5	2×10^{-12}	6×10^{-13}	2×10^{-12}
Manganese (25)	Mn 52	5	2×10^{-12}	5×10^{-13}	7×10^{-13}
	Mn 54	1	1×10^{-12}	9×10^{-13}	3×10^{-13}
	Mn 56	5	4×10^{-12}	4×10^{-13}	1×10^{-13}
Mercury (80)	Hg 197m	5	4×10^{-12}	3×10^{-12}	1×10^{-12}
	Hg 197	1	8×10^{-12}	4×10^{-12}	3×10^{-12}
	Hg 203	5	7×10^{-12}	6×10^{-13}	2×10^{-12}
Molybdenum (42)	Mo 90	5	2×10^{-12}	3×10^{-12}	2×10^{-12}
	Mo 91	1	1×10^{-12}	3×10^{-12}	2×10^{-12}
	Mo 92	5	7×10^{-12}	5×10^{-13}	3×10^{-12}
Neodymium (60)	Nd 144	5	2×10^{-12}	3×10^{-12}	2×10^{-12}
	Nd 145	1	3×10^{-12}	1×10^{-12}	8×10^{-13}
	Nd 147	5	4×10^{-12}	3×10^{-12}	1×10^{-12}
Neptunium (93)	Np 235	5	2×10^{-12}	3×10^{-12}	2×10^{-12}
	Np 236	1	2×10^{-12}	3×10^{-12}	2×10^{-12}
	Np 237	5	2×10^{-12}	3×10^{-12}	2×10^{-12}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Neptunium (93)	Np 237	S	4×10^{-11}	9×10^{-7}	1×10^{-13}	3×10^{-4}
	Np 239	I	1×10^{-10}	9×10^{-7}	4×10^{-13}	3×10^{-4}
Nickel (58)	Ni 59	S	8×10^{-7}	4×10^{-3}	3×10^{-9}	1×10^{-4}
	Ni 63	I	7×10^{-7}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Ni 65	S	5×10^{-7}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	Ni 65	I	4×10^{-7}	8×10^{-3}	3×10^{-9}	2×10^{-4}
Niobium (Columbium) (41)	Nb 93m	S	3×10^{-7}	2×10^{-3}	1×10^{-9}	7×10^{-4}
	Nb 93m	I	5×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb 95	S	1×10^{-7}	2×10^{-3}	2×10^{-9}	1×10^{-4}
	Nb 95	I	2×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-4}
Osmium (76)	Os 185	S	1×10^{-7}	3×10^{-3}	2×10^{-9}	1×10^{-4}
	Os 185	I	6×10^{-7}	3×10^{-3}	2×10^{-9}	9×10^{-4}
	Os 191m	S	5×10^{-7}	2×10^{-3}	2×10^{-9}	7×10^{-4}
	Os 191m	I	3×10^{-7}	7×10^{-3}	3×10^{-9}	3×10^{-4}
Osmium (76)	Os 191	S	9×10^{-7}	7×10^{-3}	6×10^{-9}	3×10^{-4}
	Os 191	I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Os 193	S	6×10^{-7}	5×10^{-3}	1×10^{-9}	2×10^{-4}
	Os 193	I	4×10^{-7}	2×10^{-3}	1×10^{-9}	4×10^{-4}
Palladium (46)	Pd 103	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	3×10^{-4}
	Pd 103	I	1×10^{-7}	1×10^{-3}	5×10^{-9}	3×10^{-4}
Phosphorus (15)	P 32	S	7×10^{-7}	8×10^{-3}	3×10^{-9}	9×10^{-4}
	P 32	I	6×10^{-7}	3×10^{-3}	2×10^{-9}	7×10^{-4}
Platinum (78)	Pt 191	S	7×10^{-7}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Pt 191	I	5×10^{-7}	7×10^{-3}	3×10^{-9}	2×10^{-4}
Platinum (78)	Pt 193m	S	6×10^{-7}	4×10^{-3}	3×10^{-9}	1×10^{-4}
	Pt 193m	I	3×10^{-7}	3×10^{-3}	2×10^{-9}	1×10^{-4}
	Pt 193	S	7×10^{-7}	3×10^{-3}	2×10^{-9}	1×10^{-4}
	Pt 193	I	5×10^{-7}	3×10^{-3}	2×10^{-9}	1×10^{-4}
Plutonium (94)	Pu 238	S	1×10^{-10}	3×10^{-7}	4×10^{-13}	9×10^{-4}
	Pu 238	I	3×10^{-10}	3×10^{-7}	1×10^{-13}	2×10^{-4}
	Pu 239	S	6×10^{-10}	2×10^{-7}	2×10^{-13}	1×10^{-4}
	Pu 239	I	5×10^{-10}	3×10^{-7}	3×10^{-13}	9×10^{-4}
Plutonium (94)	Pu 240	S	8×10^{-10}	3×10^{-7}	3×10^{-13}	1×10^{-4}
	Pu 240	I	4×10^{-10}	4×10^{-7}	2×10^{-13}	1×10^{-4}
	Pu 241	S	4×10^{-10}	2×10^{-7}	1×10^{-13}	3×10^{-4}
	Pu 241	I	2×10^{-10}	1×10^{-7}	6×10^{-13}	3×10^{-4}
Plutonium (94)	Pu 241	S	6×10^{-10}	8×10^{-7}	1×10^{-13}	3×10^{-4}
	Pu 241	I	9×10^{-10}	7×10^{-7}	3×10^{-13}	2×10^{-4}
Plutonium (94)	Pu 241	S	4×10^{-10}	4×10^{-7}	1×10^{-13}	1×10^{-4}
	Pu 241	I	4×10^{-10}	4×10^{-7}	1×10^{-13}	1×10^{-4}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air + ($\mu\text{Ci/ml}$)		Water ($\mu\text{Ci/ml}$)	
Plutonium (94)	Pu 242	5	2×10^{-12}	1×10^{-4}	6×10^{-14}
	Pu 243	1	4×10^{-11}	9×10^{-4}	1×10^{-12}
	Pu 243	5	2×10^{-14}	1×10^{-2}	6×10^{-14}
	Pu 244	1	2×10^{-14}	1×10^{-2}	4×10^{-14}
Polonium (84)	Po 210	5	3×10^{-11}	3×10^{-11}	1×10^{-12}
	Po 210	1	2×10^{-10}	8×10^{-4}	7×10^{-12}
Potassium (19)	K 43	5	3×10^{-14}	9×10^{-2}	7×10^{-4}
	K 43	1	1×10^{-12}	4×10^{-2}	2×10^{-2}
Protactinium (91)	Pa 143	5	2×10^{-12}	9×10^{-4}	7×10^{-12}
	Pa 143	1	2×10^{-12}	5×10^{-4}	2×10^{-2}
Promethium (61)	Pm 147	5	2×10^{-12}	1×10^{-4}	5×10^{-12}
	Pm 147	1	6×10^{-14}	6×10^{-2}	2×10^{-2}
Praseodymium (59)	Pr 143	5	1×10^{-12}	6×10^{-2}	3×10^{-2}
	Pr 143	1	3×10^{-12}	1×10^{-2}	4×10^{-2}
Protactinium (91)	Pa 230	5	2×10^{-12}	1×10^{-2}	8×10^{-12}
	Pa 231	1	8×10^{-14}	6×10^{-11}	3×10^{-4}
Radium (88)	Ra 223	5	1×10^{-12}	3×10^{-11}	3×10^{-4}
	Ra 223	1	1×10^{-10}	2×10^{-12}	9×10^{-2}
Radium (88)	Ra 226	5	6×10^{-12}	4×10^{-12}	2×10^{-2}
	Ra 226	1	2×10^{-12}	2×10^{-4}	1×10^{-2}
Radium (88)	Ra 228	5	2×10^{-12}	6×10^{-11}	7×10^{-2}
	Ra 228	1	2×10^{-10}	1×10^{-12}	4×10^{-2}
Radium (88)	Ra 228	5	3×10^{-12}	2×10^{-10}	2×10^{-10}
	Ra 228	1	7×10^{-10}	3×10^{-11}	3×10^{-4}
Radium (88)	Ra 228	5	5×10^{-11}	4×10^{-12}	3×10^{-2}
	Ra 228	1	5×10^{-11}	9×10^{-14}	2×10^{-2}
Radium (88)	Ra 228	5	7×10^{-11}	8×10^{-12}	3×10^{-2}
	Ra 228	1	4×10^{-11}	2×10^{-12}	3×10^{-2}
Radium (88)	Ra 228	5	3×10^{-12}	1×10^{-12}	3×10^{-2}
	Ra 228	1	3×10^{-12}	1×10^{-12}	3×10^{-2}
Rhenium (75)	Re 183	5	3×10^{-14}	2×10^{-12}	3×10^{-14}
	Re 183	1	2×10^{-12}	9×10^{-14}	6×10^{-14}
Rhenium (75)	Re 186	5	6×10^{-12}	3×10^{-12}	3×10^{-14}
	Re 186	1	2×10^{-12}	2×10^{-14}	9×10^{-14}
Rhenium (75)	Re 187	5	9×10^{-14}	1×10^{-12}	5×10^{-14}
	Re 187	1	7×10^{-12}	8×10^{-14}	3×10^{-14}
Rhenium (75)	Re 187	5	5×10^{-12}	7×10^{-12}	3×10^{-12}
	Re 187	1	4×10^{-12}	2×10^{-12}	3×10^{-12}
Rhodium (45)	Rh 103m	5	4×10^{-12}	1×10^{-12}	6×10^{-12}
	Rh 103m	1	2×10^{-12}	9×10^{-14}	3×10^{-12}
Rhodium (45)	Rh 105	5	8×10^{-12}	4×10^{-12}	1×10^{-12}
	Rh 105	1	6×10^{-12}	3×10^{-12}	1×10^{-12}
Rubidium (37)	Rb 86	5	3×10^{-12}	2×10^{-12}	1×10^{-12}
	Rb 86	1	3×10^{-12}	1×10^{-12}	7×10^{-12}
Rubidium (37)	Rb 87	5	7×10^{-12}	7×10^{-14}	2×10^{-12}
	Rb 87	1	3×10^{-12}	2×10^{-12}	1×10^{-12}
Rubidium (37)	Rb 87	5	3×10^{-12}	2×10^{-12}	2×10^{-12}
	Rb 87	1	7×10^{-12}	3×10^{-12}	2×10^{-12}

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APPENDIX B
Concentrations in Air and Water Above Natural Background—Continued
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Element (atomic number)	Isotope		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Ruthenium (44)	Ru 97	5	2×10^{-4}	1×10^{-4}	8×10^{-4}	4×10^{-4}
		1	2×10^{-4}	1×10^{-4}	4×10^{-4}	3×10^{-4}
	Ru 103	5	5×10^{-7}	2×10^{-7}	2×10^{-4}	8×10^{-4}
		1	8×10^{-8}	2×10^{-7}	3×10^{-4}	8×10^{-4}
	Ru 106	5	7×10^{-7}	3×10^{-7}	2×10^{-4}	1×10^{-4}
Rhodium (45)		1	5×10^{-7}	3×10^{-7}	2×10^{-4}	1×10^{-4}
	Rh 106	5	8×10^{-4}	4×10^{-4}	3×10^{-4}	1×10^{-4}
		1	4×10^{-4}	3×10^{-4}	2×10^{-4}	1×10^{-4}
	Rh 147	5	7×10^{-11}	3×10^{-11}	2×10^{-11}	6×10^{-11}
		1	3×10^{-10}	2×10^{-10}	9×10^{-11}	7×10^{-11}
Samarium (62)	Sm 147	5	6×10^{-4}	1×10^{-4}	2×10^{-4}	4×10^{-4}
		1	1×10^{-7}	1×10^{-7}	5×10^{-8}	4×10^{-8}
	Sm 153	5	5×10^{-7}	2×10^{-7}	2×10^{-7}	5×10^{-7}
		1	4×10^{-7}	2×10^{-7}	1×10^{-7}	8×10^{-7}
	Sm 154	5	3×10^{-7}	1×10^{-7}	8×10^{-8}	4×10^{-8}
Scandium (21)	Sc 46	5	2×10^{-7}	1×10^{-7}	8×10^{-8}	4×10^{-8}
		1	2×10^{-8}	1×10^{-8}	8×10^{-9}	4×10^{-9}
	Sc 47	5	4×10^{-7}	3×10^{-7}	2×10^{-7}	9×10^{-7}
		1	2×10^{-7}	3×10^{-7}	5×10^{-8}	8×10^{-8}
	Sc 48	5	2×10^{-7}	8×10^{-8}	6×10^{-8}	3×10^{-8}
Selenium (34)		1	1×10^{-7}	8×10^{-8}	3×10^{-8}	3×10^{-8}
	Se 75	5	1×10^{-4}	9×10^{-5}	4×10^{-4}	3×10^{-4}
		1	1×10^{-7}	8×10^{-8}	4×10^{-8}	3×10^{-8}
	Silicon (14)	5	4×10^{-4}	3×10^{-4}	3×10^{-4}	9×10^{-4}
		1	1×10^{-4}	6×10^{-5}	3×10^{-4}	2×10^{-4}
Silver (47)	Ag 103	5	4×10^{-7}	3×10^{-7}	2×10^{-7}	1×10^{-7}
		1	8×10^{-8}	3×10^{-7}	3×10^{-7}	1×10^{-7}
	Ag 110m	5	2×10^{-7}	9×10^{-8}	7×10^{-8}	3×10^{-8}
		1	1×10^{-8}	9×10^{-8}	3×10^{-8}	3×10^{-8}
	Ag 111	5	3×10^{-7}	1×10^{-7}	1×10^{-7}	4×10^{-7}
Xenon (54)		1	2×10^{-7}	1×10^{-7}	8×10^{-8}	4×10^{-8}
	Xe 82	5	3×10^{-7}	1×10^{-7}	6×10^{-7}	4×10^{-7}
		1	9×10^{-8}	9×10^{-8}	3×10^{-8}	3×10^{-8}
	Xe 136	5	1×10^{-4}	6×10^{-5}	4×10^{-4}	2×10^{-4}
		1	1×10^{-7}	8×10^{-8}	5×10^{-8}	3×10^{-8}
Strontium (38)	Sr 85m	5	4×10^{-7}	2×10^{-7}	1×10^{-7}	7×10^{-7}
		1	2×10^{-7}	2×10^{-7}	1×10^{-7}	7×10^{-7}
	Sr 85	5	2×10^{-7}	3×10^{-7}	8×10^{-7}	1×10^{-7}
		1	1×10^{-7}	3×10^{-7}	4×10^{-7}	2×10^{-7}
	Sr 89	5	3×10^{-4}	3×10^{-4}	3×10^{-4}	3×10^{-4}
Sulfur (16)		1	4×10^{-4}	6×10^{-4}	1×10^{-4}	3×10^{-4}
	Sr 90	5	1×10^{-4}	1×10^{-4}	2×10^{-4}	2×10^{-4}
		1	2×10^{-4}	1×10^{-4}	2×10^{-4}	4×10^{-4}
	Sr 91	5	4×10^{-7}	2×10^{-7}	2×10^{-7}	7×10^{-7}
		1	3×10^{-7}	1×10^{-7}	9×10^{-8}	5×10^{-8}
Tellurium (73)	Sr 92	5	4×10^{-7}	2×10^{-7}	2×10^{-7}	7×10^{-7}
		1	3×10^{-7}	2×10^{-7}	1×10^{-7}	6×10^{-7}
	S 33	5	3×10^{-7}	2×10^{-7}	9×10^{-7}	6×10^{-7}
		1	2×10^{-7}	8×10^{-8}	9×10^{-8}	3×10^{-8}
	Te 122	5	4×10^{-4}	1×10^{-4}	1×10^{-4}	4×10^{-4}
		1	2×10^{-4}	1×10^{-4}	7×10^{-4}	4×10^{-4}

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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	Column 2	Column 1	Column 2
			Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)
Technetium (43)	Tc 96m	S	8×10^{-7}	4×10^{-7}	3×10^{-4}	1×10^{-4}
	Tc 96	I	3×10^{-7}	3×10^{-7}	1×10^{-4}	1×10^{-4}
	Tc 96	S	4×10^{-7}	3×10^{-7}	2×10^{-4}	1×10^{-4}
	Tc 97m	I	2×10^{-7}	1×10^{-7}	8×10^{-4}	5×10^{-4}
	Tc 97m	S	2×10^{-7}	1×10^{-7}	2×10^{-4}	4×10^{-4}
	Tc 97	I	2×10^{-7}	5×10^{-7}	5×10^{-4}	2×10^{-4}
	Tc 97	S	1×10^{-7}	5×10^{-7}	4×10^{-4}	2×10^{-4}
	Tc 99m	I	3×10^{-7}	2×10^{-7}	1×10^{-4}	8×10^{-4}
	Tc 99m	S	4×10^{-7}	2×10^{-7}	1×10^{-4}	6×10^{-4}
	Tc 99	I	1×10^{-7}	8×10^{-7}	5×10^{-4}	3×10^{-4}
Tellurium (52)	Tc 99	S	2×10^{-7}	1×10^{-7}	7×10^{-4}	3×10^{-4}
	Tc 99	I	4×10^{-7}	5×10^{-7}	2×10^{-4}	2×10^{-4}
	Te 125m	S	4×10^{-7}	3×10^{-7}	1×10^{-4}	2×10^{-4}
	Te 125m	I	1×10^{-7}	3×10^{-7}	4×10^{-4}	1×10^{-4}
	Te 127m	S	1×10^{-7}	3×10^{-7}	5×10^{-4}	6×10^{-4}
	Te 127m	I	4×10^{-7}	2×10^{-7}	1×10^{-4}	5×10^{-4}
	Te 127	S	2×10^{-7}	8×10^{-7}	6×10^{-4}	3×10^{-4}
	Te 127	I	9×10^{-7}	5×10^{-7}	3×10^{-4}	2×10^{-4}
	Te 129m	S	8×10^{-7}	1×10^{-7}	3×10^{-4}	5×10^{-4}
	Te 129m	I	3×10^{-7}	6×10^{-7}	1×10^{-4}	2×10^{-4}
Terbium (65)	Te 129	S	5×10^{-7}	2×10^{-7}	2×10^{-4}	8×10^{-4}
	Te 129	I	4×10^{-7}	2×10^{-7}	1×10^{-4}	8×10^{-4}
	Te 131m	S	4×10^{-7}	2×10^{-7}	1×10^{-4}	6×10^{-4}
	Te 131m	I	2×10^{-7}	1×10^{-7}	6×10^{-4}	4×10^{-4}
	Te 133	S	2×10^{-7}	9×10^{-7}	7×10^{-4}	3×10^{-4}
	Te 133	I	1×10^{-7}	4×10^{-7}	4×10^{-4}	2×10^{-4}
	Te 140	S	1×10^{-7}	1×10^{-7}	3×10^{-4}	4×10^{-4}
	Te 140	I	3×10^{-7}	1×10^{-7}	1×10^{-4}	4×10^{-4}
	Te 140	S	2×10^{-7}	1×10^{-7}	9×10^{-4}	4×10^{-4}
	Te 140	I	1×10^{-7}	7×10^{-7}	4×10^{-4}	2×10^{-4}
Thallium (81)	Ti 201	S	2×10^{-7}	9×10^{-7}	7×10^{-4}	5×10^{-4}
	Ti 201	I	9×10^{-7}	5×10^{-7}	3×10^{-4}	3×10^{-4}
	Ti 202	S	8×10^{-7}	4×10^{-7}	3×10^{-4}	1×10^{-4}
	Ti 202	I	2×10^{-7}	2×10^{-7}	8×10^{-4}	7×10^{-4}
	Ti 204	S	6×10^{-7}	3×10^{-7}	2×10^{-4}	1×10^{-4}
	Ti 204	I	3×10^{-7}	2×10^{-7}	9×10^{-4}	6×10^{-4}
	Th 227	S	3×10^{-10}	5×10^{-10}	1×10^{-11}	2×10^{-11}
	Th 227	I	2×10^{-10}	5×10^{-10}	6×10^{-11}	2×10^{-11}
	Th 228	S	9×10^{-10}	2×10^{-10}	3×10^{-11}	7×10^{-11}
	Th 228	I	6×10^{-10}	4×10^{-10}	2×10^{-11}	1×10^{-11}
Thorium (90)	Th 230	S	2×10^{-10}	5×10^{-10}	8×10^{-11}	2×10^{-11}
	Th 230	I	1×10^{-10}	9×10^{-10}	3×10^{-11}	3×10^{-11}
	Th 231	S	1×10^{-10}	7×10^{-10}	5×10^{-11}	2×10^{-11}
	Th 231	I	1×10^{-10}	7×10^{-10}	4×10^{-11}	2×10^{-11}
	Th 232	S	5×10^{-11}	5×10^{-11}	1×10^{-11}	2×10^{-11}
	Th 232	I	3×10^{-11}	1×10^{-11}	1×10^{-11}	4×10^{-11}
	Th 232	S	6×10^{-11}	6×10^{-11}	3×10^{-11}	2×10^{-11}
	Th 232	I	6×10^{-11}	6×10^{-11}	3×10^{-11}	2×10^{-11}
	Th natural	S	6×10^{-11}	6×10^{-11}	3×10^{-11}	2×10^{-11}
	Th natural	I	6×10^{-11}	6×10^{-11}	3×10^{-11}	2×10^{-11}

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Concentrations in Air and Water Above Natural Background—Continued

[See notes at end of appendix]

Table I

Table II

Element (atomic number)	Isotope		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			+ ($\mu\text{Ci/ml}$)($\mu\text{Ci/ml}$)($\mu\text{Ci/ml}$)($\mu\text{Ci/ml}$)			
Thorium (90)	Th 234	S	6×10^{-4}	5×10^{-4}	2×10^{-4}	2×10^{-4}
		I	3×10^{-4}	3×10^{-4}	1×10^{-4}	2×10^{-4}
Thallium (81)	Tm 170	S	4×10^{-4}	1×10^{-4}	1×10^{-4}	5×10^{-4}
		I	3×10^{-4}	1×10^{-4}	1×10^{-4}	5×10^{-4}
	Tm 171	S	1×10^{-4}	1×10^{-4}	4×10^{-4}	5×10^{-4}
		I	2×10^{-4}	1×10^{-4}	6×10^{-4}	5×10^{-4}
Tin (50)	Sn 113	S	4×10^{-4}	2×10^{-4}	1×10^{-4}	9×10^{-4}
		I	5×10^{-4}	2×10^{-4}	2×10^{-4}	6×10^{-4}
	Sn 123	S	1×10^{-4}	5×10^{-4}	4×10^{-4}	2×10^{-4}
		I	8×10^{-4}	5×10^{-4}	3×10^{-4}	7×10^{-4}
Tungsten (Wolfram) (74)	W 181	S	2×10^{-4}	1×10^{-4}	8×10^{-4}	7×10^{-4}
		I	1×10^{-4}	1×10^{-4}	4×10^{-4}	3×10^{-4}
	W 183	S	8×10^{-4}	4×10^{-4}	3×10^{-4}	1×10^{-4}
		I	1×10^{-4}	3×10^{-4}	4×10^{-4}	1×10^{-4}
	W 187	S	4×10^{-4}	2×10^{-4}	2×10^{-4}	7×10^{-4}
		I	3×10^{-4}	2×10^{-4}	1×10^{-4}	4×10^{-4}
Uranium (92)	U 230	S	3×10^{-10}	1×10^{-10}	1×10^{-11}	5×10^{-10}
		I	1×10^{-10}	1×10^{-10}	4×10^{-11}	5×10^{-10}
	U 232	S	1×10^{-10}	8×10^{-11}	3×10^{-11}	3×10^{-10}
		I	3×10^{-11}	8×10^{-11}	9×10^{-12}	3×10^{-10}
	U 233	S	5×10^{-10}	9×10^{-11}	3×10^{-11}	3×10^{-10}
		I	1×10^{-10}	9×10^{-11}	4×10^{-12}	3×10^{-10}
ee U 234		S ⁴	6×10^{-10}	9×10^{-11}	2×10^{-11}	3×10^{-10}
		I	1×10^{-10}	9×10^{-11}	4×10^{-12}	3×10^{-10}
ee U 235		S ⁴	5×10^{-10}	8×10^{-11}	2×10^{-11}	3×10^{-10}
		I	1×10^{-10}	8×10^{-11}	4×10^{-12}	3×10^{-10}
	U 236	S	6×10^{-10}	1×10^{-10}	2×10^{-11}	4×10^{-10}
		I	1×10^{-10}	1×10^{-10}	4×10^{-12}	3×10^{-10}
vm U 238		S ⁴	7×10^{-11}	1×10^{-10}	3×10^{-12}	4×10^{-10}
		I	1×10^{-10}	1×10^{-10}	5×10^{-12}	4×10^{-10}
	U 240	S	2×10^{-10}	1×10^{-10}	8×10^{-12}	3×10^{-10}
		I	2×10^{-10}	1×10^{-10}	6×10^{-12}	3×10^{-10}
ee U-natural		S ⁴	1×10^{-10}	1×10^{-10}	3×10^{-12}	3×10^{-10}
		I	1×10^{-10}	1×10^{-10}	5×10^{-12}	3×10^{-10}
Vanadium (23)	V 48	S	2×10^{-4}	9×10^{-4}	6×10^{-4}	3×10^{-4}
		I	6×10^{-4}	8×10^{-4}	3×10^{-4}	3×10^{-4}
Xenon (54)	Xe 131m	Sub	2×10^{-4}		4×10^{-4}	
	Xe 133	Sub	1×10^{-4}		3×10^{-4}	
	Xe 133m	Sub	1×10^{-4}		3×10^{-4}	
	Xe 135	Sub	4×10^{-4}		1×10^{-4}	
Ytterbium (70)	Yb 173	S	7×10^{-4}	3×10^{-4}	2×10^{-4}	1×10^{-4}
		I	6×10^{-4}	3×10^{-4}	2×10^{-4}	1×10^{-4}
Yttrium (39)	Y 90	S	1×10^{-4}	4×10^{-4}	4×10^{-4}	3×10^{-4}
		I	1×10^{-4}	6×10^{-4}	2×10^{-4}	2×10^{-4}
	Y 91m	S	3×10^{-4}	1×10^{-4}	8×10^{-4}	3×10^{-4}
		I	2×10^{-4}	1×10^{-4}	6×10^{-4}	3×10^{-4}
	Y 91	S	4×10^{-4}	8×10^{-4}	1×10^{-4}	3×10^{-4}
		I	3×10^{-4}	8×10^{-4}	1×10^{-4}	3×10^{-4}
	Y 92	S	4×10^{-4}	2×10^{-4}	1×10^{-4}	6×10^{-4}
		I	3×10^{-4}	2×10^{-4}	1×10^{-4}	6×10^{-4}
	Y 93	S	2×10^{-4}	8×10^{-4}	6×10^{-4}	3×10^{-4}
		I	1×10^{-4}	8×10^{-4}	3×10^{-4}	3×10^{-4}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

Table I

Table II

Element (atomic number)	Isotope		Column 1	Column 2	Column 1	Column 2	
			Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	
Zinc (30)	Zn 65	S	1×10^{-1}	3×10^{-1}	4×10^{-4}	1×10^{-4}	
		I	6×10^{-4}	10^{-4}	2×10^{-4}	2×10^{-4}	
	Zn 69m	S	4×10^{-2}	1×10^{-2}	1×10^{-4}	7×10^{-4}	
		I	3×10^{-4}	2×10^{-4}	1×10^{-4}	4×10^{-4}	
	Zn 69	S	7×10^{-4}	5×10^{-4}	3×10^{-4}	2×10^{-4}	
		I	9×10^{-4}	5×10^{-4}	3×10^{-4}	2×10^{-4}	
Zirconium (40)	Zr 92	S	1×10^{-2}	2×10^{-2}	4×10^{-4}	8×10^{-4}	
		I	3×10^{-4}	2×10^{-4}	1×10^{-4}	8×10^{-4}	
	Zr 93	S	1×10^{-2}	2×10^{-2}	4×10^{-4}	6×10^{-4}	
		I	3×10^{-4}	2×10^{-4}	1×10^{-4}	6×10^{-4}	
	Zr 97	S	1×10^{-2}	5×10^{-2}	4×10^{-4}	2×10^{-4}	
		I	9×10^{-4}	3×10^{-4}	3×10^{-4}	2×10^{-4}	
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.		Sub	1×10^{-4}		3×10^{-4}		
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours.			3×10^{-10}	9×10^{-10}	1×10^{-10}	3×10^{-10}	
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission.			6×10^{-11}	4×10^{-11}	2×10^{-11}	3×10^{-11}	

S: Soluble (S); Insoluble (I)

C: means that values given are for submersion in a semiprecipitated infinite cloud of airborne material

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

14. For soluble mixtures of U-238, U-234 and U-235 in air chemical toxicity may be the limiting factor. If the percent by weight (enrichment) of U-235 is less than 5, the concentration value for a 40-hour workweek, Table I, is 0.2 milligram uranium per cubic meter of air average. For any enrichment, the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed 8×10^{-4} SA $\mu\text{Ci-hr/ml}$, where SA is the specific activity of the uranium inhaled. The concentration value for Table II is 0.007 milligram uranium per cubic meter of air. The specific activity for natural uranium is 6.77×10^{-4} curies per gram U. The specific activity for other mixtures of U-238, U-235 and U-234, if not known, shall be:

$$SA = 3.8 \times 10^{-4} \text{ curies/gram U} \quad \text{U-depleted}$$

$$SA = (0.4 + 0.38 E + 0.0034 E^2) 10^{-4} \text{ E} \geq 0.75$$

where E is the percentage by weight of U-235 expressed as percent.

* Amended 37 F.R. 23319.

** Amended 39 F.R. 13990; footnote redesignated 40 F.R. 50704.

*** Amended 40 F.R. 50704.

† Amended 38 F.R. 29314.

‡ Amended 39 F.R. 15463; redesignated 40 F.R. 50704.

PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

Appendix C to §§20.1-20.601

Material	Microcuries
Americium-241	.01
Antimony-122	100
Antimony-124	10
Antimony-125	10
Antimony-126	100
Argon-78	10
Argon-79	10
Argon-80	10
Argon-81	100
Barium-131	10
Barium-133	10
Bismuth-210	10
Bismuth-212	1
Bromine-82	10
Cadmium-109	10
Cadmium-115m	10
Cadmium-115	100
Calcium-45	10
Calcium-47	10
Carbon-14	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Cesium-131	1,000
Cesium-134m	100
Cesium-134	1
Cesium-135	10
Cesium-136	10
Cesium-137	10
Chlorine-36	10
Chlorine-38	10
Chromium-51	1,000
Cobalt-58m	10
Cobalt-58	10
Cobalt-60	1
Copper-64	100
Dysprosium-165	10
Dysprosium-166	100
Erbium-169	100
Erbium-171	100
Europium-152 9.2 h	100
Europium-152 13 yr	1
Europium-154	1
Europium-155	10
Fluorine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	100
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1
Indium-113m	10
Indium-114m	10
Indium-115m	10
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	100
Krypton-87	10
Lanthanum-140	10
Lutetium-177	100
Manganese-52	10
Manganese-54	10
Manganese-56	10
Mercury-197m	100
Mercury-197	100
Mercury-203	10
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-50	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10

Material	Microcuries
Osmium-191m ¹	100
Osmium-197	100
Osmium-185	100
Palladium-103	100
Palladium-106	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	10
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	0.1
Rhenium-186	100
Rhenium-188	100
Rhodium-103m	100
Rhodium-105	100
Rubidium-86	10
Rubidium-87	10
Ruthenium-97	100
Ruthenium-103	10
Ruthenium-106	10
Ruthenium-108	1
Samarium-151	10
Samarium-153	100
Scandium-46	10
Scandium-47	100
Scandium-48	10
Selenium-75	10
Silicon-31	100
Silver-105	10
Silver-110m	1
Silver-111	100
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1
Strontium-91	10
Strontium-92	10
Sulphur-35	100
Tantalum-182	10
Technetium-96	10
Technetium-97m	100
Technetium-97	100
Technetium-99m	100
Technetium-99	10
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	100
Tellurium-129m	10
Tellurium-129	100
Tellurium-131m	10
Tellurium-132	10
Terbium-160	10
Thallium-200	100
Thallium-201	100
Thallium-202	100
Thallium-204	10
***Thorium (natural) ¹	100
Thulium-170	10
Thulium-171	10
Tin-113	10
Tin-125	10
Tungsten-181	10
Tungsten-185	10
Tungsten-187	100
***Uranium (natural) ²	100
Uranium-233	0.1
Uranium-234 - Uranium-235	0.1
Vanadium-48	10
Xenon-131m	1,000
Xenon-133	100
Xenon-135	100
Ytterbium-175	100
Yttrium-90	10
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zirconium-93	10
Zirconium-95	10
Zirconium-97	10

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

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

Note.—For purposes of § 20.303, 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").

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

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

* Amended 36 FR 16898.

** Amended 39 FR 23490.

➤ Appendix D to §§20.1-20.601—
United States Nuclear Regulatory Commission Regional Offices

	Addresses	Telephone (24 hours)
Region I: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont	USNRC, 475 Archway Road, King of Prussia, PA 19406	(215) 337-5000 (FTS) 346-3006
Region II: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia	USNRC, 101 Marietta Street, NW, Suite 2000, Atlanta, GA 30323	(404) 331-1503 (FTS) 242-4503
Region III: Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin	USNRC, 799 Roosevelt Road, Glen Ellyn, IL 60137	(708) 790-5500 (FTS) 388-5500
Region IV: Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming	USNRC, 611 Ryan Plaza Drive, Suite 1000, Arlington, TX 76011	(817) 860-8100 (FTS) 728-8100
Region V: Field Office	USNRC, Region IV Uranium Recovery Field Office, 730 Grimm Street, P.O. Box 25325, Denver, CO 80215	(303) 236-2805 (FTS) 776-2805
Region VI: Alaska, Arizona, California, Hawaii, Nevada, Oregon, Pacific Trust Territories, and Washington	USNRC, 1450 Main Lane, Suite 700, Walnut Creek, CA 94596	(415) 975-0200

➤ Subpart A—General Provisions

§ 20.1001 Purpose.

(a) The regulations in this part establish standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the Nuclear Regulatory Commission. These regulations are issued under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended.

(b) It is the purpose of the regulations in this part to control the receipt, possession, use, transfer, and disposal of licensed material by any licensee in such a manner that the total dose to an individual (including doses resulting from licensed and unlicensed radioactive material and from radiation sources other than background radiation) does not exceed the standards for protection against radiation prescribed in the regulations in this part. However, nothing in this part shall be construed as limiting actions that may be necessary to protect health and safety.

§ 20.1002 Scope.

The regulations in this part apply to persons licensed by the Commission to receive, possess, use, transfer, or dispose of byproduct, source, or special nuclear material or to operate a production or utilization facility under parts 30 through 35, 39, 40, 50, 60, 61, 70, or 72 of this chapter. The limits in this part do not apply to doses due to background radiation, to exposure of patients to radiation for the purpose of

medical diagnosis or therapy, or to voluntary participation in medical research programs.

§ 20.1003 Definitions.

As used in this part:

Absorbed dose means the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).

Act means the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.), as amended.

Activity is the rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).

Adult means an individual 18 or more years of age.

Airborne radioactive material means radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

Airborne radioactivity area means a room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations—

- (1) In excess of the derived air concentrations (DACs) specified in appendix B, to §§ 20.1001–20.2401, or
- (2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

ALARA (acronym for "as low as is reasonably achievable") means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

Annual limit on intake (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected

radionuclides are given in Table 1. Columns 1 and 2, of appendix B to §§ 20.1001–20.2401).

Background radiation means radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. "Background radiation" does not include radiation from source, byproduct, or special nuclear materials regulated by the Commission.

Bioassay (radiobioassay) means the determination of kinds, quantities or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

Byproduct material means—

- (1) 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; and
- (2) The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "byproduct material" within this definition.

Class (or *lung class* or *inhalation class*) means a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days.

Collective dose is the sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

Commission means the Nuclear Regulatory Commission or its duly authorized representatives.

Committed dose equivalent ($H_{T,50}$) means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

Committed effective dose equivalent ($H_{E,50}$) is the sum of the products of the weighting factors applicable to each of

the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues ($H_{E,50} = \sum W_T H_{T,50}$).

Controlled area means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

Declared pregnant woman means a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Deep-dose equivalent (H_d), which applies to external whole-body exposure, is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm²).

Department means the Department of Energy established by the Department of Energy Organization Act (Pub. L. 95–91, 91 Stat. 565, 42 U.S.C. 7101 et seq.) to the extent that the Department, or its duly authorized representatives, exercises functions formerly vested in the U.S. Atomic Energy Commission, its Chairman, members, officers, and components and transferred to the U.S. Energy Research and Development Administration and to the Administrator thereof pursuant to sections 104 (b), (c), and (d) of the Energy Reorganization Act of 1974 (Pub. L. 93–438, 88 Stat. 1233 at 1237, 42 U.S.C. 5814) and retransferred to the Secretary of Energy pursuant to section 301(a) of the Department of Energy Organization Act (Pub. L. 95–91, 91 Stat. 565 at 577–578, 42 U.S.C. 7151).

Derived air concentration (DAC) means the concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table 1, Column 3, of appendix B to §§ 20.1001–20.2401.

Derived air concentration-hour (DAC-hour) is the product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived air concentration for each radionuclide) and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 5 rems (0.05 Sv).

Dose or radiation dose is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section.

Dose equivalent (H_T) means the product of the absorbed dose in tissue,

quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

Dosimetry processor means an individual or an organization that processes and evaluates individual monitoring equipment in order to determine the radiation dose delivered to the equipment ($H_{E,50} = \sum w_T H_{T,50}$).

Effective dose equivalent (H_E) is the sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (w_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \sum w_T H_T$).

Embryo/fetus means the developing human organism from conception until the time of birth.

Entrance or access point means any location through which an individual could gain access to radiation areas or to radioactive materials. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

Exposure means being exposed to ionizing radiation or to radioactive material.

External dose means that portion of the dose equivalent received from radiation sources outside the body.

Extremity means hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

Eye dose equivalent applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm²).

Generally applicable environmental radiation standards means standards issued by the Environmental Protection Agency (EPA) under the authority of the Atomic Energy Act of 1954, as amended, that impose limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material.

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.

Gray [See § 20.1004].

High radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30

centimeters from the radiation source or from any surface that the radiation penetrates.

Individual means any human being.

Individual monitoring means—

(1) The assessment of dose equivalent by the use of devices designed to be worn by an individual;

(2) The assessment of committed effective dose equivalent by bioassay (see *Bioassay*) or by determination of the time-weighted air concentrations to which an individual has been exposed, i.e., DAC-hours; or

(3) The assessment of dose equivalent by the use of survey data.

Individual Monitoring Devices (*individual monitoring equipment*) means devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers, and personal ("lapel") air sampling devices.

Internal dose means that portion of the dose equivalent received from radioactive material taken into the body.

License means a license issued under the regulations in parts 30 through 35, 39, 40, 50, 60, 61, 70, or 72 of this chapter.

Licensed material means source material, special nuclear material, or byproduct material received, possessed, used, transferred or disposed of under a general or specific license issued by the Commission.

Licensee means the holder of a license.

Limits (dose limits) means the permissible upper bounds of radiation doses.

Lost or missing licensed material means licensed material whose location is unknown. It includes material that has been shipped but has not reached its destination and whose location cannot be readily traced in the transportation system.

Member of the public means an individual in a controlled or unrestricted area. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

Minor means an individual less than 18 years of age.

Monitoring (radiation monitoring, radiation protection monitoring) means the measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses.

Nonstochastic effect means health effects, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced

cataract formation is an example of a nonstochastic effect (also called a deterministic effect).

NRC means the Nuclear Regulatory Commission or its duly authorized representatives.

Occupational dose means the dose received by an individual in a restricted area or in the course of employment in which the individual's assigned duties involve exposure to radiation and to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the general public.

Person means—

(1) Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission or the Department of Energy (except that the Department shall be considered a person within the meaning of the regulations in 10 CFR chapter I to the extent that its facilities and activities are subject to the licensing and related regulatory authority of the Commission under section 202 of the Energy Reorganization Act of 1974 (88 Stat. 1244), the Uranium Mill Tailings Radiation Control Act of 1978 [92 Stat. 3021], the Nuclear Waste Policy Act of 1982 [96 Stat. 2201], and section 3(b)(2) of the Low-Level Radioactive Waste Policy Amendments Act of 1985 [99 Stat. 1842]), any State or any political subdivision of or any political entity within a State, any foreign government or nation or any political subdivision of any such government or nation, or other entity; and

(2) Any legal successor, representative, agent, or agency of the foregoing.

Planned special exposure means an infrequent exposure to radiation, separate from and in addition to the annual dose limits.

Public dose means the dose received by a member of the public from exposure to radiation and to radioactive material released by a licensee, or to another source of radiation either within a licensee's controlled area or in unrestricted areas. It does not include occupational dose or doses received from background radiation, as a patient from medical practices, or from voluntary participation in medical research programs.

Quality Factor (Q) means the modifying factor (listed in tables

1004(b).1 and 1004(b).2 of § 20.1004) that is used to derive dose equivalent from absorbed dose.

Quarter means a period of time equal to one-fourth of the year observed by the licensee (approximately 13 consecutive weeks), providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

Rad (See § 20.1004).

Radiation (ionizing radiation) means alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in this part, does not include non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

Radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Reference man means a hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

Rem (See § 20.1004).

Respiratory protective device means an apparatus, such as a respirator, used to reduce the individual's intake of airborne radioactive materials.

Restricted area means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Sanitary sewerage means a system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee.

Shallow-dose equivalent (H_s), which applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm²) averaged over an area of 1 square centimeter.

Sievert (See § 20.1004).

Site boundary means that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.

Source material means—

(1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or

(2) Ores that contain, by weight, one-twentieth of 1 percent (0.05 percent), or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material.

Special nuclear material means—

(1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the Commission, pursuant to the provisions of section 51 of the Act, determines to be special nuclear material, but does not include source material; or

(2) Any material artificially enriched by any of the foregoing but does not include source material.

Stochastic effects means health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

Survey means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Total Effective Dose Equivalent (TEDE) means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Unrestricted area means an area, access to which is neither limited nor controlled by the licensee.

Uranium fuel cycle means the operations of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel to the extent that these activities directly support the production of electrical power for public use. Uranium fuel cycle does not include mining operations, operations at waste disposal sites, transportation of radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and byproduct materials from the cycle.

Very high radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 hour at 1 meter from a radiation source or from any surface that the radiation penetrates.

(Note: At very high doses received at high dose rates, units of absorbed dose (e.g., rads and grays) are appropriate, rather than units of dose equivalent (e.g., rems and sieverts)).

Week means 7 consecutive days starting on Sunday.

Weighting factor w_T , for an organ or tissue (T) is the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of w_T are:

ORGAN DOSE WEIGHTING FACTORS

Organ or tissue	w_T
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30
Whole Body	1.00

¹ 0.30 results from 0.06 for each of 5 "remainder" organs (excluding the skin and the lens of the eye) that receive the high-dose.

² For the purpose of weighting the external whole body dose (for adding it to the internal dose), a single weighting factor, $w_T = 1.0$, has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

Whole body means, for purposes of external exposure, head, trunk (including male gonads), arms above the elbow, or legs above the knee.

Working level (WL) is any combination of short-lived radon daughters (for radon-222: polonium-218, lead-214, bismuth-214, and polonium-214; and for radon-220: polonium-218, lead-212, bismuth-212, and polonium-212) in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha particle energy.

Working level month (WLM) means an exposure to 1 working level for 170 hours (2,000 working hours per year/12 months per year = approximately 170 hours per month).

Year means the period of time beginning in January used to determine compliance with the provisions of this part. The licensee may change the starting date of the year used to determine compliance by the licensee provided that the change is made at the beginning of the year and that no day is

omitted or duplicated in consecutive years.

§ 20.1004 Units of radiation dose.

(a) Definitions. As used in this part, the units of radiation dose are:

Gray (Gy) is the SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule/kilogram (100 rads).

Rad is the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram (0.01 gray).

Rem is the special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem = 0.01 sievert).

Sievert is the SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rems).

(b) As used in this part, the quality factors for converting absorbed dose to dose equivalent are shown in table 1004(b).1.

TABLE 1004(b).1.—QUALITY FACTORS AND ABSORBED DOSE EQUIVALENCIES

Type of radiation	Quality factor	Absorbed dose equal to a unit dose equivalent *
	(Q)	
X-, gamma, or beta radiation	1	1
Alpha particles, multiple-charged particles, fission fragments and heavy particles of unknown charge	20	0.05
Neutrons of unknown energy	10	0.1
High-energy protons	10	0.1

* Absorbed dose in rad equal to 1 rem or the absorbed dose in gray equal to 1 sievert.

(c) If it is more convenient to measure the neutron fluence rate than to determine the neutron dose equivalent rate in rems per hour or sieverts per hour, as provided in paragraph (b) of this section, 1 rem (0.01 Sv) of neutron radiation of unknown energies may, for purposes of the regulations in this part, be assumed to result from a total fluence of 25 million neutrons per square centimeter incident upon the body. If sufficient information exists to estimate the approximate energy distribution of the neutrons, the licensee may use the fluence rate per unit dose equivalent or the appropriate Q value from table 1004(b).2 to convert a measured tissue dose in rads to dose equivalent in rems.

TABLE 1004(b).2.—MEAN QUALITY FACTORS, Q, AND FLUENCE PER UNIT DOSE EQUIVALENT FOR MONOENERGETIC NEUTRONS

	Neutron energy (MeV)	Quality factor * (Q)	Fluence per unit dose equivalent * (neutrons cm ⁻² rem ⁻¹)
(thermal)	2.5 × 10 ⁻⁴	2	980 × 10 ⁴
	1 × 10 ⁻³	2	980 × 10 ⁴
	1 × 10 ⁻²	2	810 × 10 ⁴
	1 × 10 ⁻¹	2	810 × 10 ⁴
	1 × 10 ⁻¹	2	840 × 10 ⁴
	1 × 10 ⁻¹	2	980 × 10 ⁴
	1 × 10 ⁻¹	2.5	1010 × 10 ⁴
	1 × 10 ⁻¹	7.5	170 × 10 ⁴
	5 × 10 ⁻¹	11	39 × 10 ⁴
	1	11	27 × 10 ⁴
	2.5	9	29 × 10 ⁴
	5	8	23 × 10 ⁴
	7	7	24 × 10 ⁴
	10	6.5	24 × 10 ⁴
	14	7.5	17 × 10 ⁴
	20	6	16 × 10 ⁴
	40	7	14 × 10 ⁴
	60	5.5	16 × 10 ⁴
	1 × 10 ¹	4	20 × 10 ⁴
	2 × 10 ¹	3.5	19 × 10 ⁴
	3 × 10 ¹	3.5	16 × 10 ⁴
	4 × 10 ¹	3.5	14 × 10 ⁴

* Value of quality factor (Q) at the point where the dose equivalent is maximum in a 30-cm diameter cylinder tissue-equivalent phantom.

* Monoenergetic neutrons incident normally on a 30-cm diameter cylinder tissue-equivalent phantom.

§ 20.1005 Units of radioactivity.

For the purposes of this part, activity is expressed in the special unit of curies (Ci) or in the SI unit of becquerels (Bq), or their multiples, or disintegrations (transformations) per unit of time.

(a) One becquerel = 1 disintegration per second (s⁻¹). (b) One curie = 3.7 × 10¹⁰ disintegrations per second = 3.7 × 10¹⁰ becquerels = 2.22 × 10¹² disintegrations per minute.

§ 20.1006 Interpretations.

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

§ 20.1007 Communications.

Unless otherwise specified, communications or reports concerning the regulations in this part should be addressed to the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, DC 20555. A communication, report, or application may be delivered in person to the Office of the Executive Director for Operations, 11555 Rockville Pike, Rockville, MD 20852.

§ 20.1008 Implementation.

(a) Licensees shall implement the provisions of §§ 20.1001–20.2401 on or before January 1, 1993. If a licensee chooses to implement the provisions of §§ 20.1001–20.2401 prior to January 1, 1993, the licensee shall implement all provisions of these sections not otherwise exempted by paragraph (d) of this section, and shall provide written notification to either the Director of the Office of Nuclear Materials Safety and Safeguards or the Director of the Office of Nuclear Reactor Regulation, as appropriate, that the licensee is adopting early implementation of §§ 20.1001–20.2401 and associated appendices. Until January 1, 1993, or until the licensee notifies the Commission of early implementation, compliance will be required with §§ 20.1–20.601 of this part.

(b) After the time the licensee implements §§ 20.1001–20.2401, the applicable section of §§ 20.1001–20.2401 shall be used in lieu of any section in §§ 20.1–20.601 of this part that is cited in license conditions or technical specifications, except as specified in paragraphs (c), (d) and (e) of this section. If the requirements of this part are more restrictive than the existing license condition, then the licensee shall comply with this part unless exempted by paragraph (d) of this section.

(c) Any existing license condition or technical specification that is more restrictive than a requirement in §§ 20.1001–20.2401 remains in force until there is a technical specification change, license amendment, or license renewal.

(d) If a license condition or technical specification exempted a licensee from a provision of Part 20 in §§ 20.1–20.601, it exempts a licensee from the corresponding provision of §§ 20.1001–20.2401.

(e) If a license condition cites provisions in §§ 20.1–20.601 and there are no corresponding provisions in §§ 20.1001–20.2401, then the license condition remains in force until there is a technical specification change, license amendment, or license renewal that modifies or removes this condition.

§ 20.1009 Reporting, recording, and application requirements: OMB approval.

(a) The Nuclear Regulatory Commission will submit the information collection requirements contained in this part to the Office of Management and Budget for approval as required by the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 et seq.). The information collection requirements in this part will not become effective until OMB clearance is obtained and published in the Federal Register.

(b) The information collection requirements contained in this part appear in §§ 20.1101, 20.1202, 20.1204, 20.1206, 20.1301, 20.1301, 20.1601, 20.1603, 20.1703, 20.1901, 20.1902, 20.1904, 20.1906, 20.2002, 20.2004, 20.2006, 20.2102, 20.2103, 20.2104, 20.2105, 20.2106, 20.2107, 20.2108, 20.2109, 20.2110, 20.2201, 20.2202, 20.2203, 20.2204, 20.2206, Appendix F to §§ 20.1001-20.2401, and NRC Form 4 and NRC Form 5.

Subpart B—Radiation Protection Programs

§ 20.1101 Radiation protection programs.

(a) Each licensee shall develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of this part. (See § 20.2102 for recordkeeping requirements relating to these programs.)

(b) The licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).

(c) The licensee shall periodically (at least annually) review the radiation protection program content and implementation.

Subpart C—Occupational Dose Limits

§ 20.1201 Occupational dose limits for adults.

(a) The licensee shall control the occupational dose to individual adults, except for planned special exposures under § 20.1206, to the following dose limits.

(1) An annual limit, which is the more limiting of—

(i) The total effective dose equivalent being equal to 5 rems (0.05 Sv); or

(ii) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv).

(2) The annual limits to the lens of the eye, to the skin, and to the extremities, which are:

(i) An eye dose equivalent of 15 rems (0.15 Sv), and

(ii) A shallow-dose equivalent of 50 rems (0.50 Sv) to the skin or to any extremity.

(b) Doses received in excess of the annual limits, including doses received during accidents, emergencies, and planned special exposures, must be subtracted from the limits for planned special exposures that the individual may receive during the current year (see

§ 20.1206(e)(1)) and during the individual's lifetime (see § 20.1206(e)(2)).

(c) The assigned deep-dose equivalent and shallow-dose equivalent must be for the part of the body receiving the highest exposure. The deep-dose equivalent, eye dose equivalent and shallow-dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable.

(d) Derived air concentration (DAC) and annual limit on intake (ALI) values are presented in table 1 of appendix B to §§ 20.1001-20.2401 and may be used to determine the individual's dose (see § 20.2106) and to demonstrate compliance with the occupational dose limits.

(e) In addition to the annual dose limits, the licensee shall limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity (see footnote 3 of appendix B to §§ 20.1001-20.2401).

(f) The licensee shall reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person (see § 20.2104(e)).

§ 20.1202 Compliance with requirements for summation of external and internal doses.

(a) If the licensee is required to monitor under both §§ 20.1502(a) and (b), the licensee shall demonstrate compliance with the dose limits by summing external and internal doses. If the licensee is required to monitor only under § 20.1502(a) or only under § 20.1502(b), then summation is not required to demonstrate compliance with the dose limits. The licensee may demonstrate compliance with the requirements for summation of external and internal doses by meeting one of the conditions specified in paragraph (b) of this section and the conditions in paragraphs (c) and (d) of this section.

(Note: The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.)

(b) *Intake by inhalation.* If the only intake of radionuclides is by inhalation, the total effective dose equivalent limit is not exceeded if the sum of the deep-dose equivalent divided by the total effective dose equivalent limit, and one of the following, does not exceed unity:

(1) The sum of the fractions of the inhalation ALI for each radionuclide, or

(2) The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000, or

(3) The sum of the calculated committed effective dose equivalents to all significantly irradiated¹ organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit.

(c) *Intake by oral ingestion.* If the occupationally exposed individual also receives an intake of radionuclides by oral ingestion greater than 10 percent of the applicable oral ALI, the licensee shall account for this intake and include it in demonstrating compliance with the limits.

(d) *Intake through wounds or absorption through skin.* The licensee shall evaluate and, to the extent practical, account for intakes through wounds or skin absorption.

Note: The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be further evaluated.

§ 20.1203 Determination of external dose from airborne radioactive material.

Licensees shall, when determining the dose from airborne radioactive material, include the contribution to the deep-dose equivalent, eye dose equivalent, and shallow-dose equivalent from external exposure to the radioactive cloud (see appendix B to §§ 20.1001-20.2401, footnotes 1 and 2).

Note: Airborne radioactivity measurements and DAC values should not be used as the primary means to assess the deep-dose equivalent when the airborne radioactive material includes radionuclides other than noble gases or if the cloud of airborne radioactive material is not relatively uniform. The determination of the deep-dose equivalent to an individual should be based upon measurements using instruments or individual monitoring devices.

§ 20.1204 Determination of internal exposure.

(a) For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee shall, when required under § 20.1502, take suitable and timely measurements of—

(1) Concentrations of radioactive materials in air in work areas; or

(2) Quantities of radionuclides in the body; or

¹ An organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, w_T , and the committed dose equivalent, H_{50} , per unit intake is greater than 10 percent of the maximum weighted value of H_{50} (i.e., $w_T H_{50}$) per unit intake for any organ or tissue.

(3) Quantities of radionuclides excreted from the body; or

(4) Combinations of these measurements.

(b) Unless respiratory protective equipment is used, as provided in § 20.1703, or the assessment of intake is based on bioassays, the licensee shall assume that an individual inhales radioactive material at the airborne concentration in which the individual is present.

(c) When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior of the material in an individual is known, the licensee may—

(1) Use that information to calculate the committed effective dose equivalent, and, if used, the licensee shall document that information in the individual's record; and

(2) Upon prior approval of the Commission, adjust the DAC or ALI values to reflect the actual physical and chemical characteristics of airborne radioactive material (e.g., aerosol size distribution or density); and

(3) Separately assess the contribution of fractional intakes of Class D, W, or Y compounds of a given radionuclide (see appendix B to §§ 20.1001–20.2401) to the committed effective dose equivalent.

(d) If the licensee chooses to assess intakes of Class Y material using the measurements given in § 20.1204(a)(2) or (3), the licensee may delay the recording and reporting of the assessments for periods up to 7 months, unless otherwise required by §§ 20.2202 or 20.2203, in order to permit the licensee to make additional measurements basic to the assessments.

(e) If the identity and concentration of each radionuclide in a mixture are known, the fraction of the DAC applicable to the mixture for use in calculating DAC-hours must be either—

(1) The sum of the ratios of the concentration to the appropriate DAC value (e.g., D, W, Y) from appendix B to §§ 20.1001–20.2401 for each radionuclide in the mixture; or

(2) The ratio of the total concentration for all radionuclides in the mixture to the most restrictive DAC value for any radionuclide in the mixture.

(f) If the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture must be the most restrictive DAC of any radionuclide in the mixture.

(g) When a mixture of radionuclides in air exists, licensees may disregard certain radionuclides in the mixture if—

(1) The licensee uses the total activity of the mixture in demonstrating

compliance with the dose limits in § 20.1201 and in complying with the monitoring requirements in § 20.1502(b), and

(2) The concentration of any radionuclide disregarded is less than 10 percent of its DAC; and

(3) The sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30 percent.

(h)(1) In order to calculate the committed effective dose equivalent, the licensee may assume that the inhalation of one ALI, or an exposure of 2,000 DAC-hours, results in a committed effective dose equivalent of 5 rems (0.05 Sv) for radionuclides that have their ALIs or DACs based on the committed effective dose equivalent.

(2) When the ALI (and the associated DAC) is determined by the nonstochastic organ dose limit of 50 rems (0.5 Sv), the intake of radionuclides that would result in a committed effective dose equivalent of 5 rems (0.05 Sv) (the stochastic ALI) is listed in parentheses in table 1 of appendix B to §§ 20.1001–20.2401. In this case, the licensee may, as a simplifying assumption, use the stochastic ALIs to determine committed effective dose equivalent. However, if the licensee uses the stochastic ALIs, the licensee must also demonstrate that the limit in § 20.1201(a)(1)(ii) is met.

§ 20.1205 [Reserved]

§ 20.1206 Planned special exposures.

A licensee may authorize an adult worker to receive doses in addition to and accounted for separately from the doses received under the limits specified in § 20.1201 provided that each of the following conditions is satisfied—

(a) The licensee authorizes a planned special exposure only in an exceptional situation when alternatives that might avoid the higher exposure are unavailable or impractical.

(b) The licensee (and employer if the employer is not the licensee) specifically authorizes the planned special exposure, in writing, before the exposure occurs.

(c) Before a planned special exposure, the licensee ensures that the individuals involved are—

(1) Informed of the purpose of the planned operation;

(2) Informed of the estimated doses and associated potential risks and specific radiation levels or other conditions that might be involved in performing the task; and

(3) Instructed in the measures to be taken to keep the dose ALARA considering other risks that may be present.

(d) Prior to permitting an individual to participate in a planned special exposure, the licensee ascertains prior doses as required by § 20.1204(b) during the lifetime of the individual for each individual involved.

(e) Subject to § 20.1201(b), the licensee does not authorize a planned special exposure that would cause an individual to receive a dose from all planned special exposures and all doses in excess of the limits to exceed—

(1) The numerical values of any of the dose limits in § 20.1201(a) in any year; and

(2) Five times the annual dose limits in § 20.1201(a) during the individual's lifetime.

(f) The licensee maintains records of the conduct of a planned special exposure in accordance with § 20.2105 and submits a written report in accordance with § 20.2204.

(g) The licensee records the best estimate of the dose resulting from the planned special exposure in the individual's record and informs the individual, in writing, of the dose within 30 days from the date of the planned special exposure. The dose from planned special exposures is not to be considered in controlling future occupational dose of the individual under § 20.1201(a) but is to be included in evaluations required by § 20.1206 (d) and (e).

§ 20.1207 Occupational dose limits for minors.

The annual occupational dose limits for minors are 10 percent of the annual dose limits specified for adult workers in § 20.1201.

§ 20.1208 Dose to an embryo/fetus.

(a) The licensee shall ensure that the dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv). (For recordkeeping requirements, see § 20.2106.)

(b) The licensee shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in paragraph (a) of this section.

(c) The dose to an embryo/fetus shall be taken as the sum of—

(1) The deep-dose equivalent to the declared pregnant woman; and

(2) The dose to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

(d) If the dose to the embryo/fetus is found to have exceeded 0.5 rem (5 mSv),

or is within 0.05 rem (0.5 mSv) of this dose, by the time the woman declares the pregnancy to the licensee, the licensee shall be deemed to be in compliance with paragraph (a) of this section if the additional dose to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

Subpart D—Radiation Dose Limits for Individual Members of the Public

§ 20.1301 Dose limits for individual members of the public.

(a) Each licensee shall conduct operations so that—

(1) The total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of the dose contribution from the licensee's disposal of radioactive material into sanitary sewerage in accordance with § 20.2003; and

(2) The dose in any unrestricted area from external sources does not exceed 0.002 rem (0.02 mSv) in any one hour.

(b) If the licensee permits members of the public to have access to controlled areas, the limits for members of the public continue to apply to those individuals.

(c) A licensee or license applicant may apply for prior NRC authorization to operate up to an annual dose limit for an individual member of the public of 0.5 rem (5 mSv). The licensee or license applicant shall include the following information in this application:

(1) Demonstration of the need for and the expected duration of operations in excess of the limit in paragraph (a) of this section;

(2) The licensee's program to assess and control dose within the 0.5 rem (5 mSv) annual limit; and

(3) The procedures to be followed to maintain the dose as low as is reasonably achievable.

(d) In addition to the requirements of this part, a licensee subject to the provisions of EPA's generally applicable environmental radiation standards in 40 CFR Part 190 shall comply with those standards.

(e) The Commission may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee may release in effluents in order to restrict the collective dose.

§ 20.1302 Compliance with dose limits for individual members of the public.

(a) The licensee shall make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas and radioactive

materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in § 20.1301.

(b) A licensee shall show compliance with the annual dose limit in § 20.1301 by—

(1) Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit; or

(2) Demonstrating that—

(i) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in table 2 of appendix B to §§ 20.1001–20.2401; and

(ii) If an individual were continually present in an unrestricted area, the dose from external sources would not exceed 0.002 rem (0.02 mSv) in an hour and 0.05 rem (0.5 mSv) in a year.

(c) Upon approval from the Commission, the licensee may adjust the effluent concentration values in appendix B to §§ 20.1001–20.2401, table 2, for members of the public, to take into account the actual physical and chemical characteristics of the effluents (e.g., aerosol size distribution, solubility, density, radioactive decay equilibrium, chemical form).

Subpart E—(Reserved)

Subpart F—Surveys and Monitoring

§ 20.1501 General.

(a) Each licensee shall make or cause to be made, surveys that—

(1) May be necessary for the licensee to comply with the regulations in this part; and

(2) Are reasonable under the circumstances to evaluate—

(i) The extent of radiation levels; and

(ii) Concentrations or quantities of radioactive material; and

(iii) The potential radiological hazards that could be present.

(b) The licensee shall ensure that instruments and equipment used for quantitative radiation measurements (e.g., dose rate and effluent monitoring) are calibrated periodically for the radiation measured.

(c) All personnel dosimeters (except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to the extremities) that require processing to determine the radiation dose and that are used by licensees to comply with § 20.1201, with other applicable provisions of this chapter, or with

conditions specified in a license must be processed and evaluated by a dosimetry processor—

(1) Holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology; and

(2) Approved in this accreditation process for the type of radiation or radiations included in the NVLAP program that most closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

§ 20.1502 Conditions requiring individual monitoring of external and internal occupational dose.

Each licensee shall monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of this part. As a minimum—

(a) Each licensee shall monitor occupational exposure to radiation and shall supply and require the use of individual monitoring devices by—

(1) Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in § 20.1201(a).

(2) Minors and declared pregnant women likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of any of the applicable limits in § 20.1207 or § 20.1208; and

(3) Individuals entering a high or very high radiation area.

(b) Each licensee shall monitor (see § 20.1204) the occupational intake of radioactive material by and assess the committed effective dose equivalent to—

(1) Adults likely to receive, in 1 year, an intake in excess of 10 percent of the applicable ALI(s) in table 1, Columns 1 and 2, of appendix B to §§ 20.1001–20.2401; and

(2) Minors and declared pregnant women likely to receive, in 1 year, a committed effective dose equivalent in excess of 0.05 rem (0.5 mSv).

Subpart G—Control of Exposure From External Sources in Restricted Areas

§ 20.1601 Control of access to high radiation areas.

(a) The licensee shall ensure that each entrance or access point to a high radiation area has one or more of the following features—

(1) A control device that, upon entry into the area, causes the level of radiation to be reduced below that level at which an individual might receive a

deep-dose equivalent of 0.1 rem (1 mSv) in 1 hour at 50 centimeters from the radiation source or from any surface that the radiation penetrates;

(2) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or

(3) Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

(b) In place of the controls required by paragraph (a) of this section for a high radiation area, the licensee may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry.

(c) A licensee may apply to the Commission for approval of alternative methods for controlling access to high radiation areas.

(d) The licensee shall establish the controls required by paragraphs (a) and (c) of this section in a way that does not prevent individuals from leaving a high radiation area.

(e) Control is not required for each entrance or access point to a room or other area that is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled in accordance with the regulations of the Department of Transportation provided that—

(1) The packages do not remain in the area longer than 3 days; and

(2) The dose rate at 1 meter from the external surface of any package does not exceed 0.01 rem (0.1 mSv) per hour.

(f) Control of entrance or access to rooms or other areas in hospitals is not required solely because of the presence of patients containing radioactive material, provided that there are personnel in attendance who will take the necessary precautions to prevent the exposure of individuals to radiation or radioactive material in excess of the limits established in this part and to operate within the ALARA provisions of the licensee's radiation protection program.

§ 20.1602 Control of access to very high radiation areas.

In addition to the requirements in § 20.1601, the licensee shall institute additional measures to ensure that an individual is not able to gain unauthorized or inadvertent access to areas in which radiation levels could be encountered at 500 rads (5 grays) or more in 1 hour at 1 meter from a radiation source or any surface through which the radiation penetrates.

§ 20.1603 Control of access to very high radiation areas—irradiators.

(a) Each area in which there may exist radiation levels in excess of 500 rads (5 grays) in 1 hour at 1 meter from a sealed radioactive source² that is used to irradiate materials must meet the following requirements.

(1) Each entrance or access point must be equipped with entry control devices which—

(i) Function automatically to prevent any individual from inadvertently entering the area when very high radiation levels exist;

(ii) Permit deliberate entry into the area only after a control device is actuated that causes the radiation level within the area, from the sealed source, to be reduced below that at which it would be possible for an individual to receive a deep-dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour; and

(iii) Prevent operation of the source if the source would produce radiation levels in the area that could result in a deep-dose equivalent to an individual in excess of 0.1 rem (1 mSv) in 1 hour.

(2) Additional control devices must be provided so that, upon failure of the entry control devices to function as required by paragraph (a)(1) of this section—

(i) The radiation level within the area, from the sealed source, is reduced below that at which it would be possible for an individual to receive a deep-dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour; and

(ii) Conspicuous visible and audible alarm signals are generated to make an individual attempting to enter the area aware of the hazard and at least one other authorized individual, who is physically present, familiar with the activity, and prepared to render or summon assistance, aware of the failure of the entry control devices.

(3) The licensee shall provide control devices so that, upon failure or removal of physical radiation barriers other than the source's shielded storage container—

(i) The radiation level from the source is reduced below that at which it would

² This section applies to radiation from byproduct, source, or special nuclear materials that are used in sealed sources in non-self-shielded irradiators. This section does not apply to radioactive sources that are used in teletherapy, in radiography, or in completely self-shielded irradiators in which the source is both stored and operated within the same shielding radiation barrier and, in the designed configuration of the irradiator, is always physically inaccessible to any individual and cannot create high levels of radiation in an area that is accessible to any individual. This section also does not apply to sources from which the radiation is incidental to some other use or to nuclear reactor-generated radiation.

be possible for an individual to receive a deep-dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour; and

(ii) Conspicuous visible and audible alarm signals are generated to make potentially affected individuals aware of the hazard and the licensee or at least one other individual, who is familiar with the activity and prepared to render or summon assistance, aware of the failure or removal of the physical barrier.

(4) When the shield for the stored source is a liquid, the licensee shall provide means to monitor the integrity of the shield and to signal, automatically, loss of adequate shielding.

(5) Physical radiation barriers that comprise permanent structural components, such as walls, that have no credible probability of failure or removal in ordinary circumstances need not meet the requirements of paragraphs (a) (3) and (4) of this section.

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

(7) Each area must be controlled by use of such administrative procedures and such devices as are necessary to ensure that the area is cleared of personnel prior to each use of the source.

(8) Each area must be checked by a radiation measurement to ensure that, prior to the first individual's entry into the area after any use of the source, the radiation level from the source in the area is below that at which it would be possible for an individual to receive a deep-dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour.

(9) The entry control devices required in paragraph (a)(1) of this section must have been tested for proper functioning (see § 20.2109 for recordkeeping requirements).

(i) Testing must be conducted prior to initial operation with the source of radiation on any day (unless operations were continued uninterrupted from the previous day); and

(ii) Testing must be conducted prior to resumption of operation of the source of radiation after any unintended interruption; and

(iii) The licensee shall submit and adhere to a schedule for periodic tests of the entry control and warning systems.

(10) The licensee may not conduct operations, other than those necessary to place the source in safe condition or to effect repairs on controls, unless control devices are functioning properly.

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

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

(c) The entry control devices required by paragraphs (a) and (b) of this section must be established in such a way that no individual will be prevented from leaving the area.

Subpart H—Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas

§ 20.1701 Use of process or other engineering controls.

The licensee shall use, to the extent practicable, process or other engineering controls (e.g., containment or ventilation) to control the concentrations of radioactive material in air.

§ 20.1702 Use of other controls.

When it is not practicable to apply process or other engineering controls to control the concentrations of radioactive material in air to values below those that define an airborne radioactivity area, the licensee shall, consistent with maintaining the total effective dose equivalent ALARA, increase monitoring and limit intakes by one or more of the following means:

- (a) Control of access;
- (b) Limitation of exposure times;
- (c) Use of respiratory protection equipment; or
- (d) Other controls.

§ 20.1703 Use of individual respiratory protection equipment.

(a) If the licensee uses respiratory protection equipment to limit intakes pursuant to § 20.1702—

(1) The licensee shall use only respiratory protection equipment that is tested and certified or had certification extended by the National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA).

(2) If the licensee wishes to use equipment that has not been tested or certified by NIOSH/MSHA, has not had certification extended by NIOSH/MSHA, or for which there is no schedule for testing or certification, the licensee shall submit an application for authorized use of that equipment, including a demonstration by testing, or a demonstration on the basis of reliable test information, that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use.

(3) The licensee shall implement and maintain a respiratory protection program that includes—

(i) Air sampling sufficient to identify the potential hazard, permit proper equipment selection, and estimate exposures;

(ii) Surveys and bioassays, as appropriate, to evaluate actual intakes;

(iii) Testing of respirators for operability immediately prior to each use;

(iv) Written procedures regarding selection, fitting, issuance, maintenance, and testing of respirators, including testing for operability immediately prior to each use; supervision and training of personnel; monitoring, including air sampling and bioassays; and recordkeeping; and

(v) Determination by a physician prior to initial fitting of respirators, and at least every 12 months thereafter, that the individual user is physically able to

use the respiratory protection equipment.

(4) The licensee shall issue a written policy statement on respirator usage covering—

(i) The use of process or other engineering controls, instead of respirators;

(ii) The routine, nonroutine, and emergency use of respirators; and

(iii) The periods of respirator use and relief from respirator use.

(5) The licensee shall advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other conditions that might require such relief.

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

(b) In estimating exposure of individuals to airborne radioactive materials, the licensee may make allowance for respiratory protection equipment used to limit intakes pursuant to § 20.1702, provided that the following conditions, in addition to those in § 20.1703(a), are satisfied:

(1) The licensee selects respiratory protection equipment that provides a protection factor (see appendix A to §§ 20.1001–20.2401) greater than the multiple by which peak concentrations of airborne radioactive materials in the working area are expected to exceed the values specified in appendix B to §§ 20.1001–20.2401, table 1, column 3. If the selection of a respiratory protection device with a protection factor greater than the peak concentration is inconsistent with the goal specified in § 20.1702 of keeping the total effective dose equivalent ALARA, the licensee may select respiratory protection equipment with a lower protection factor only if such a selection would result in keeping the total effective dose equivalent ALARA. The concentration of radioactive material in the air that is inhaled when respirators are worn may be initially estimated by dividing the average concentration in air, during each period of uninterrupted use, by the protection factor. If the exposure is later found to be greater than estimated, the corrected value must be used; if the exposure is later found to be less than estimated, the corrected value may be used.

(2) The licensee shall obtain authorization from the Commission

before assigning respiratory protection factors in excess of those specified in appendix A to §§ 20.1001-20.2401. The Commission may authorize a licensee to use higher protection factors on receipt of an application that—

(i) Describes the situation for which a need exists for higher protection factors, and

(ii) Demonstrates that the respiratory protection equipment provides these higher protection factors under the proposed conditions of use.

(c) The licensee shall use as emergency devices only respiratory protection equipment that has been specifically certified or had certification extended for emergency use by NOISH/MSHA.

(d) The licensee shall notify, in writing, the Director of the appropriate NRC Regional Office listed in appendix D to §§ 20.1001-20.2401 at least 30 days before the date that respiratory protection equipment is first used under

the provisions of either § 20.1703 (a) or (b).

§ 20.1704 Further restrictions on the use of respiratory protection equipment.

The Commission may impose restrictions in addition to those in §§ 20.1702, 20.1703, and appendix A to §§ 20.1001-20.2401 to—

(a) Ensure that the respiratory protection program of the licensee is adequate to limit exposures of individuals to airborne radioactive materials; and

(b) Limit the extent to which a licensee may use respiratory protection equipment instead of process or other engineering controls.

Subpart I—Storage and Control of Licensed Material

§ 20.1801 Security of stored material.

The licensee shall secure from

unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

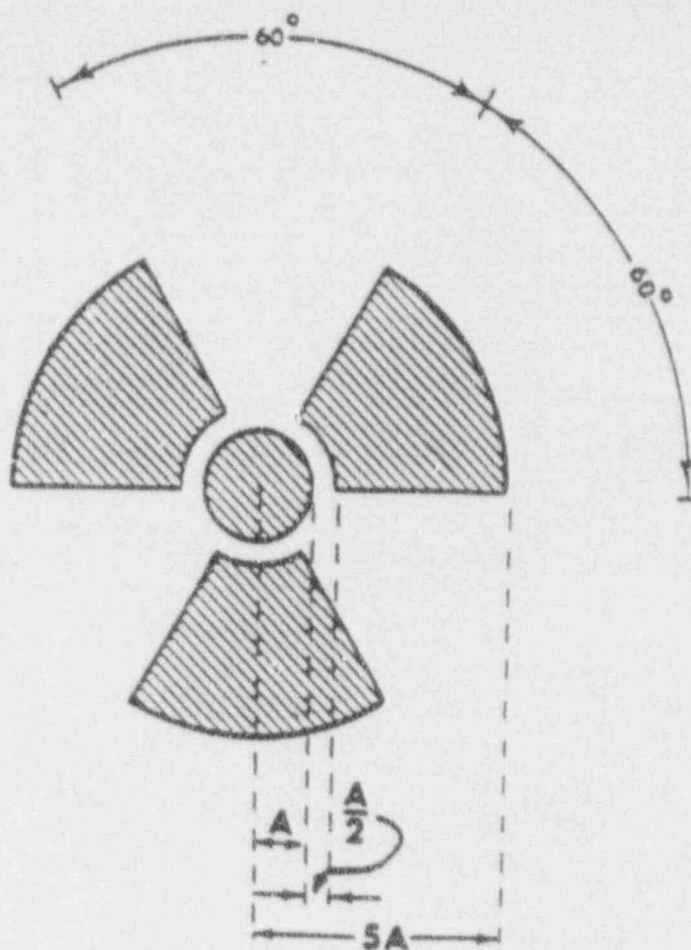
§ 20.1802 Control of material not in storage.

The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Subpart J—Precautionary Procedures

§ 20.1901 Caution signs.

(a) *Standard radiation symbol.* Unless otherwise authorized by the Commission, the symbol prescribed by this part shall use the colors magenta, or purple, or black on yellow background. The symbol prescribed by this part is the three-bladed design:



RADIATION SYMBOL

(1) Cross-hatched area is to be magenta, or purple, or black, and

(2) The background is to be yellow.

(b) *Exception to color requirements for standard radiation symbol.*

Notwithstanding the requirements of paragraph (a) of this section, licensees are authorized to label sources, source holders, or device components containing sources of licensed materials that are subjected to high temperatures, with conspicuously etched or stamped radiation caution symbols and without a color requirement.

(c) *Additional information on signs and labels.* In addition to the contents of signs and labels prescribed in this part, the licensee may provide, on or near the required signs and labels, additional information, as appropriate, to make individuals aware of potential radiation exposures and to minimize the exposures.

§ 20.1902 Posting requirements.

(a) *Posting of radiation areas.* The licensee shall post each radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA."

(b) *Posting of high radiation areas.* The licensee shall post each high radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA."

(c) *Posting of very high radiation areas.* The licensee shall post each very high radiation area with a conspicuous sign or signs bearing the radiation symbol and words "GRAVE DANGER, VERY HIGH RADIATION AREA."

(d) *Posting of airborne radioactivity areas.* The licensee shall post each airborne radioactivity area with a conspicuous sign or signs bearing the

radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA."

(e) *Posting of areas or rooms in which licensed material is used or stored.* The licensee shall post each area or room in which there is used or stored an amount of licensed material exceeding 10 times the quantity of such material specified in appendix C to §§ 20.1001-20.2401 with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

§ 20.1903 Exceptions to posting requirements.

(a) A licensee is not required to post caution signs in areas or rooms containing radioactive materials for

periods of less than 8 hours, if each of the following conditions is met:

(1) The materials are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure of individuals to radiation or radioactive materials in excess of the limits established in this part; and

(2) The area or room is subject to the licensee's control.

(b) Rooms or other areas in hospitals that are occupied by patients are not required to be posted with caution signs pursuant to § 20.1902 provided that—

(1) The patient is being treated with sealed sources or has been treated with unsealed radioactive material in quantities less than 30 millicuries (110 MBq, or the measured dose rate at 1 meter from the patient is less than 0.005 rem (0.05 mSv) per hour; and

(2) There are personnel in attendance who will take the necessary precautions to prevent the exposure of individuals to radiation or radioactive material in excess of the limits established in this part and to operate within the ALARA provisions of the licensee's radiation protection program.

(c) 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 at 30 centimeters from the surface of the source container or housing does not exceed 0.005 rem (0.05 mSv) per hour.

§ 20.1904 Labeling containers.

(a) The licensee shall ensure that each container of licensed material bears a durable, clearly visible label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label must also provide sufficient information (such as the radionuclide(s) present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials, and mass enrichment) to permit individuals handling or using the containers, or working in the vicinity of the containers, to take precautions to avoid or minimize exposures.

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

§ 20.1905 Exemptions to labeling requirements.

A licensee is not required to label—

(a) Containers holding licensed material in quantities less than the

quantities listed in appendix C to §§ 20.1001–20.2401; or

(b) Containers holding licensed material in concentrations less than those specified in table 3 of appendix B to §§ 20.1001–20.2401; or

(c) Containers attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the limits established by this part; or

(d) Containers when they are in transport and packaged and labeled in accordance with the regulations of the Department of Transportation;³ or

(e) Containers that are accessible only to individuals authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to these individuals by a readily available written record (examples of containers of this type are containers in locations such as water-filled canals, storage vaults, or hot cells). The record must be retained as long as the containers are in use for the purpose indicated on the record; or

(f) Installed manufacturing or process equipment, such as reactor components, piping, and tanks.

§ 20.1906 Procedures for receiving and opening packages.

(a) Each licensee who expects to receive a package containing quantities of radioactive material in excess of a Type A quantity, as defined in § 71.4 and appendix A to part 71 of this chapter, shall make arrangements to receive—

(1) The package when the carrier offers it for delivery; or

(2) Notification of the arrival of the package at the carrier's terminal and to take possession of the package expeditiously.

(b) Each licensee shall monitor the external surfaces of a package known to contain radioactive material for radioactive contamination and radiation levels if the package—

(1) Is labeled as containing radioactive material; or

(2) Has evidence of potential contamination, such as packages that are crushed, wet, or damaged.

(c) The licensee shall perform the monitoring required by paragraph (b) of this section as soon as practicable after receipt of the package, but not later than 3 hours after the package is received at the licensee's facility if it is received

³ Labeling of packages containing radioactive materials is required by the Department of Transportation (DOT) if the amount and type of radioactive material exceeds the limits for an excepted quantity or article as defined and limited by DOT regulations 49 CFR 173.403 (m) and (w) and 173.421–424.

during the licensee's normal working hours, or not later than 3 hours from the beginning of the next working day if it is received after working hours.

(d) The licensee shall immediately notify the final delivery carrier and, by telephone and telegram, mailgram, or facsimile, the Administrator of the appropriate NRC Regional Office listed in appendix D to §§ 20.1001–20.2401 when—

(1) Removable radioactive surface contamination exceeds the limits of § 71.87(i) of this chapter; or

(2) External radiation levels exceed the limits of § 71.47 of this chapter.

(e) Each licensee shall—

(1) Establish, maintain, and retain written procedures for safely opening packages in which radioactive material is received; and

(2) Ensure that the procedures are followed and that due consideration is given to special instructions for the type of package being opened.

(f) Licensees transferring special form sources in licensee-owned or licensee-operated vehicles to and from a work site are exempt from the contamination monitoring requirements of paragraph (b) of this section, but are not exempt from the survey requirement in paragraph (b) of this section for measuring radiation levels that is required to ensure that the source is still properly lodged in its shield.

Subpart K—Waste Disposal

§ 20.2001 General requirements.

(a) A licensee shall dispose of licensed material only—

(1) By transfer to an authorized recipient as provided in § 20.2006 or in the regulations in parts 30, 40, 60, 61, 70, or 72 of this chapter; or

(2) By decay in storage; or

(3) By release in effluents within the limits in § 20.1301; or

(4) As authorized under §§ 20.2002, 20.2003, 20.2004, or § 20.2005.

(b) A person must be specifically licensed to receive waste containing licensed material from other persons for:

(1) Treatment prior to disposal; or

(2) Treatment or disposal by incineration; or

(3) Decay in storage; or

(4) Disposal at a land disposal facility licensed under part 61 of this chapter; or

(5) Disposal at a geologic repository under part 60 of this chapter.

§ 20.2002 Method for obtaining approval of proposed disposal procedures.

A licensee or applicant for a license may apply to the Commission for approval of proposed procedures, not

otherwise authorized in the regulations in this chapter, to dispose of licensed material generated in the licensee's activities. Each application shall include:

- (a) A description of the waste containing licensed material to be disposed of, including the physical and chemical properties important to risk evaluation, and the proposed manner and conditions of waste disposal; and
- (b) An analysis and evaluation of pertinent information on the nature of the environment; and
- (c) The nature and location of other potentially affected licensed and unlicensed facilities; and
- (d) Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in this part.

§ 20.2003 Disposal by release into sanitary sewerage.

(a) A licensee may discharge licensed material into sanitary sewerage if each of the following conditions is satisfied:

- (1) The material is readily soluble (or is readily dispersible biological material) in water; and
- (2) The quantity of licensed or other radioactive material that the licensee releases into the sewer in 1 month divided by the average monthly volume of water released into the sewer by the licensee does not exceed the concentration listed in table 3 of appendix B to §§ 20.1001-20.2401; and
- (3) If more than one radionuclide is released, the following conditions must also be satisfied:
 - (i) The licensee shall determine the fraction of the limit in table 3 of appendix B to §§ 20.1001-20.2401 represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the concentration of that radionuclide listed in table 3 of appendix B to §§ 20.1001-20.2401; and
 - (ii) The sum of the fractions for each radionuclide required by paragraph (a)(3)(i) of this section does not exceed unity; and
- (4) The total quantity of licensed and other radioactive material that the licensee releases into the sanitary sewerage system in a year does not exceed 5 curies (185 GBq) of hydrogen-3, 1 curie (37 GBq) of carbon-14, and 1 curie (37 GBq) of all other radioactive materials combined.

(b) Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to the limitations contained in paragraph (a) of this section.

§ 20.2004 Treatment or disposal by incineration.

A licensee may treat or dispose of licensed material by incineration only in the amounts and forms specified in § 20.2005 or as specifically approved by the Commission pursuant to § 20.2002.

§ 20.2005 Disposal of specific wastes.

(a) A licensee may dispose of the following licensed material as if it were not radioactive:

- (1) 0.05 microcurie (1.85 kBq), or less, of hydrogen-3 or carbon-14 per gram of medium used for liquid scintillation counting; and
- (2) 0.05 microcurie (1.85 kBq), or less, of hydrogen-3 or carbon-14 per gram of animal tissue, averaged over the weight of the entire animal.

(b) A licensee may not dispose of tissue under paragraph (a)(2) of this section in a manner that would permit its use either as food for humans or as animal feed.

(c) The licensee shall maintain records in accordance with § 20.2108.

§ 20.2006 Transfer for disposal and manifests.

(a) The requirements of this section and appendix F to §§ 20.1001-20.2401 are designed to control transfers of low-level radioactive waste intended for disposal at a land disposal facility (as defined in part 61 of this chapter), establish a manifest tracking system, and supplement existing requirements concerning transfers and recordkeeping for those wastes.

(b) Each shipment of radioactive waste intended for disposal at a licensed land disposal facility must be accompanied by a shipment manifest as specified in section I of appendix F to §§ 20.1001-20.2401.

(c) Each shipment manifest must include a certification by the waste generator as specified in section II of appendix F to §§ 20.1001-20.2401.

(d) Each person involved in the transfer for disposal and disposal of waste, including the waste generator, waste collector, waste processor, and disposal facility operator, shall comply with the requirements specified in section III of appendix F to §§ 20.1001-20.2401.

§ 20.2007 Compliance with environmental and health protection regulations.

Nothing in this subpart relieves the licensee from complying with other applicable Federal, State, and local regulations governing any other toxic or hazardous properties of materials that may be disposed of under this subpart.

Subpart L—Records

§ 20.2101 General provisions.

(a) Each licensee shall use the units: curie, rad, rem, including multiples and subdivisions, and shall clearly indicate the units of all quantities on records required by this part.

(b) The licensee shall make a clear distinction among the quantities entered on the records required by this part (e.g., total effective dose equivalent, shallow-dose equivalent, eye dose equivalent, deep-dose equivalent, committed effective dose equivalent).

§ 20.2102 Records of radiation protection programs.

(a) Each licensee shall maintain records of the radiation protection program, including:

- (1) The provisions of the program; and
- (2) Audits and other reviews of program content and implementation.

(b) The licensee shall retain the records required by paragraph (a)(1) of this section until the Commission terminates each pertinent license requiring the record. The licensee shall retain the records required by paragraph (a)(2) of this section for 3 years after the record is made.

§ 20.2103 Records of surveys.

(a) Each licensee shall maintain records showing the results of surveys and calibrations required by §§ 20.1501 and 20.1906(b). The licensee shall retain these records for 3 years after the record is made.

(b) The licensee shall retain each of the following records until the Commission terminates each pertinent license requiring the record:

- (1) Records of the results of surveys to determine the dose from external sources and used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents; and
- (2) Records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose; and
- (3) Records showing the results of air sampling, surveys, and bioassays required pursuant to § 20.1703(a)(3) (i) and (ii); and
- (4) Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.

(c) Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.

§ 20.2104 Determination of prior occupational dose.

(a) For each individual who may enter the licensee's restricted or controlled area and is likely to receive, in a year,

an occupational dose requiring monitoring pursuant to § 20.1502, the licensee shall—

(1) Determine the occupational radiation dose received during the current year; and

(2) Attempt to obtain the records of lifetime cumulative occupational radiation dose.

(b) Prior to permitting an individual to participate in a planned special exposure, the licensee shall determine—

(1) The internal and external doses from all previous planned special exposures; and

(2) All doses in excess of the limits (including doses received during accidents and emergencies) received during the lifetime of the individual.

(c) In complying with the requirements of paragraph (a) of this section, a licensee may—

(1) Accept, as a record of the occupational dose that the individual received during the current year, a written signed statement from the individual, or from the individual's most recent employer for work involving radiation exposure, that discloses the nature and the amount of any occupational dose that the individual may have received during the current year;

(2) Accept, as the record of lifetime cumulative radiation dose, an up-to-date NRC Form 4, or equivalent, signed by the individual and countersigned by an appropriate official of the most recent employer for work involving radiation exposure, or the individual's current employer (if the individual is not employed by the licensee); and

(3) Obtain reports of the individual's dose equivalent(s) from the most recent employer for work involving radiation exposure, or the individual's current employer (if the individual is not employed by the licensee) by telephone, telegram, electronic media, or letter. The licensee shall request a written verification of the dose data if the authenticity of the transmitted report cannot be established.

(d) The licensee shall record the exposure history, as required by paragraph (a) of this section, on NRC Form 4, or other clear and legible record, of all the information required on that form.⁴ The form or record must show

⁴ Licensees are not required to reevaluate the separate external dose equivalents and internal committed dose equivalents or intakes of radionuclides assessed under §§ 20.1-20.8.1. Further, occupational exposure histories obtained and recorded on NRC Form 4 before January 1, 1991, would not have included effective dose equivalent, but may be used in the absence of specific information on the intake of radionuclides by the individual.

each period in which the individual received occupational exposure to radiation or radioactive material and must be signed by the individual who received the exposure. For each period for which the licensee obtains reports, the licensee shall use the dose shown in the report in preparing NRC Form 4. For any period in which the licensee does not obtain a report, the licensee shall place a notation on NRC Form 4 indicating the periods of time for which data are not available.

(e) If the licensee is unable to obtain a complete record of an individual's current and previously accumulated occupational dose, the licensee shall assume—

(1) In establishing administrative controls under § 20.1201(f) for the current year, that the allowable dose limit for the individual is reduced by 1.25 rems (12.5 mSv) for each quarter for which records were unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure; and

(2) That the individual is not available for planned special exposures.

(f) The licensee shall retain the records on NRC Form 4 or equivalent until the Commission terminates each pertinent license requiring this record. The licensee shall retain records used in preparing NRC Form 4 for 3 years after the record is made.

§ 20.2105 Records of planned special exposures.

(a) For each use of the provisions of § 20.1206 for planned special exposures, the licensee shall maintain records that describe—

(1) The exceptional circumstances requiring the use of a planned special exposure; and

(2) The name of the management official who authorized the planned special exposure and a copy of the signed authorization; and

(3) What actions were necessary; and

(4) Why the actions were necessary; and

(5) How doses were maintained ALARA; and

(6) What individual and collective doses were expected to result, and the doses actually received in the planned special exposure.

(b) The licensee shall retain the records until the Commission terminates each pertinent license requiring these records.

§ 20.2106 Records of individual monitoring results.

(a) *Recordkeeping requirement.* Each licensee shall maintain records of doses received by all individuals for whom

monitoring was required pursuant to § 20.1502, and records of doses received during planned special exposures, accidents, and emergency conditions. These records⁵ must include, when applicable—

(1) The deep-dose equivalent to the whole body, eye dose equivalent, shallow-dose equivalent to the skin, and shallow-dose equivalent to the extremities; and

(2) The estimated intake or body burden of radionuclides (see § 20.1202); and

(3) The committed effective dose equivalent assigned to the intake or body burden of radionuclides; and

(4) The specific information used to calculate the committed effective dose equivalent pursuant to § 20.1204(c); and

(5) The total effective dose equivalent when required by § 20.1202; and

(6) The total of the deep-dose equivalent and the committed dose to the organ receiving the highest total dose.

(b) *Recordkeeping frequency.* The licensee shall make entries of the records specified in paragraph (a) of this section at least annually.

(c) *Recordkeeping format.* The licensee shall maintain the records specified in paragraph (a) of this section on NRC Form 5, in accordance with the instructions for NRC Form 5, or in clear and legible records containing all the information required by NRC Form 5.

(d) *Privacy protection.* The records required under this section should be protected from public disclosure because of their personal privacy nature. These records are protected by most State privacy laws and, when transferred to the NRC, are protected by the Privacy Act of 1974, Public Law 93-579, 5 U.S.C. 552a, and the Commission's regulations in 10 CFR part 9.

(e) The licensee shall maintain the records of dose to an embryo/fetus with the records of dose to the declared pregnant woman. The declaration of pregnancy shall also be kept on file, but may be maintained separately from the dose records.

(f) The licensee shall retain each required form or record until the Commission terminates each pertinent license requiring the record.

§ 20.2107 Records of dose to individual members of the public.

(a) Each licensee shall maintain records sufficient to demonstrate compliance with the dose limit for

⁵ Assessments of dose equivalent and records made using units in effect before the licensee's adoption of this part need not be changed.

individual members of the public (see § 20.1301).

(b) The licensee shall retain the records required by paragraph (a) of this section until the Commission terminates each pertinent license requiring the record.

§ 20.2108 Records of waste disposal.

(a) Each licensee shall maintain records of the disposal of licensed materials made under §§ 20.2002, 20.2003, 20.2004, 20.2005, 10 CFR part 61 and disposal by burial in soil, including burials authorized before January 28, 1981.*

(b) The licensee shall retain the records required by paragraph (a) of this section until the Commission terminates each pertinent license requiring the record.

§ 20.2109 Records of testing entry control devices for very high radiation areas.

(a) Each licensee shall maintain records of tests made under § 20.1603(a)(9) on entry control devices for very high radiation areas. These records must include the date, time, and results of each such test of function.

(b) The licensee shall retain the records required by paragraph (a) of this section for 3 years after the record is made.

§ 20.2110 Form of records.

Each record required by this part must be legible throughout the specified retention period. The record may be the original or a reproduced copy or a microform provided that the copy or microform is authenticated by authorized personnel and that the microform is capable of producing a clear copy throughout the required retention period. The record may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period. Records, such as letters, drawings, and specifications, must include all pertinent information, such as stamps, initials, and signatures. The licensee shall maintain adequate safeguards against tampering with and loss of records.

Subpart M—Reports

§ 20.2201 Reports of theft or loss of licensed material.

(a) Telephone reports. (1) Each licensee shall report by telephone as follows:

* A previous § 20.304 permitted burial of small quantities of licensed materials in soil before January 28, 1981, without specific Commission authorization.

(i) Immediately after its occurrence becomes known to the licensee, any lost, stolen, or missing licensed material in an aggregate quantity equal to or greater than 1,000 times the quantity specified in appendix C to §§ 20.1001–20.2401 under such circumstances that it appears to the licensee that an exposure could result to persons in unrestricted areas; or

(ii) Within 30 days after the occurrence of any lost, stolen, or missing licensed material becomes known to the licensee, all licensed material in a quantity greater than 10 times the quantity specified in appendix C to §§ 20.1001–20.2401 that is still missing at this time.

(2) Reports must be made as follows:

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

(ii) All other licensees shall make reports to the NRC Operations Center.

(b) *Written reports.* (1) Each licensee required to make a report under paragraph (a) of this section shall, within 30 days after making the telephone report, make a written report setting forth the following information:

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

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

(iii) A statement of disposition, or probable disposition, of the licensed material involved; and

(iv) Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas; and

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

(vi) Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed material.

(2) Reports must be made as follows:

(i) For holders of an operating license for a nuclear power plant, the events included in paragraph (b) of this section must be reported in accordance with the procedures described in § 50.73(b), (c), (d), (e), and (g) of this chapter and must include the information required in paragraph (b)(1) of this section, and

(ii) All other licensees shall make reports to the Administrator of the appropriate NRC Regional Office listed in appendix D to §§ 20.1001–20.2401.

(c) A duplicate report is not required under paragraph (b) of this section if the

licensee is also required to submit a report pursuant to §§ 30.55(c), 40.64(c), 50.72, 50.73, 70.52, 73.27(b), 73.67(e)(3)(vi), 73.67(g)(3)(iii), 73.71, or § 150.19(c) of this chapter.

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

(e) The licensee shall prepare any report filed with the Commission pursuant to this section so that names of individuals who may have received exposure to radiation are stated in a separate and detachable part of the report.

§ 20.2202 Notification of incidents.

(a) Immediate notification.

Notwithstanding any other requirements for notification, each licensee shall immediately report any event involving byproduct, source, or special nuclear material possessed by the licensee that may have caused or threatens to cause any of the following conditions—

(1) An individual to receive—

(i) A total effective dose equivalent of 25 rems (0.25 Sv) or more; or

(ii) An eye dose equivalent of 75 rems (0.75 Sv) or more; or

(iii) A shallow-dose equivalent to the skin or extremities of 250 rads (2.5 Gy) or more; or

(2) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the occupational annual limit on intake (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures); or

(3) A loss of 1 working week, or more of the operation of any facilities affected; or

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

(b) Twenty-four hour notification. Each licensee shall, within 24 hours of discovery of the event, report any event involving loss of control of licensed material possessed by the licensee that may have caused, or threatens to cause, any of the following conditions:

(1) An individual to receive, in a period of 24 hours—

(i) A total effective dose equivalent exceeding 5 rems (0.05 Sv); or

(ii) An eye dose equivalent exceeding 15 rems (0.15 Sv); or

(iii) A shallow-dose equivalent to the skin or extremities exceeding 50 rems (0.5 Sv); or

(2) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational annual limit on intake (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures); or

(3) A loss of 1 day or more of the operation of any facilities affected; or

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

(c) The licensee shall prepare any report filed with the Commission pursuant to this section so that names of individuals who have received exposure to radiation or radioactive material are stated in a separate and detachable part of the report.

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

(1) Licensees having an installed Emergency Notification System shall make the reports required by paragraphs (a) and (b) of this section to the NRC Operations Center in accordance with 10 CFR 50.72; and

(2) All other licensees shall make the reports required by paragraphs (a) and (b) of this section by telephone to the NRC Operations Center and by telegram, mailgram, or facsimile to the Administrator of the appropriate NRC Regional Office listed in appendix D to §§ 20.1001-20.2401.

(e) The provisions of this section do not include doses that result from planned special exposures, that are within the limits for planned special exposures, and that are reported under § 20.2204.

§ 20.2203 Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the limits.

(a) Reportable events. In addition to the notification required by § 20.2202, each licensee shall submit a written report within 30 days after learning of any of the following occurrences:

(1) Any incident for which notification is required by § 20.2202; or

(2) Doses in excess of any of the following:

(i) The occupational dose limits for adults in § 20.1201; or

(ii) The occupational dose limits for a minor in § 20.1207; or

(iii) The limits for an embryo/fetus of a declared pregnant woman in § 20.1208; or

(iv) The limits for an individual member of the public in § 20.1301; or

(v) Any applicable limit in the license; or

(3) Levels of radiation or

concentrations of radioactive material in—

(i) A restricted area in excess of any applicable limit in the license; or

(ii) An unrestricted area in excess of 10 times any applicable limit set forth in this part or in the license (whether or not involving exposure of any individual in excess of the limits in § 20.1301); or

(4) For licensees subject to the provisions of EPA's generally applicable environmental radiation standards in 40 CFR part 190, levels of radiation or releases of radioactive material in excess of those standards, or of license conditions related to those standards.

(b) Contents of reports. (1) Each report required by paragraph (a) of this section must describe the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:

(i) Estimates of each individual's dose; and

(ii) The levels of radiation and concentrations of radioactive material involved; and

(iii) The cause of the elevated exposures, dose rates, or concentrations; and

(iv) Corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, generally applicable environmental standards, and associated license conditions.

(2) Each report filed pursuant to paragraph (a) of this section must include for each individual¹ exposed: the name, Social Security account number, and date of birth. The report must be prepared so that this information is stated in a separate and detachable part of the report.

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

(d) All licensees, other than those holding an operating license for a nuclear power plant, who make reports under paragraph (a) of this section shall submit the report in writing to the U.S. Nuclear Regulatory Commission, Document Control Desk, Washington, DC 20555, with a copy to the appropriate NRC Regional Office listed in appendix D to §§ 20.1001-20.2401.

¹ With respect to the limit for the embryo-fetus (§ 20.1208), the identifiers should be those of the declared pregnant woman.

§ 20.2204 Reports of planned special exposures.

The licensee shall submit a written report to the Administrator of the appropriate NRC Regional Office listed in appendix D to §§ 20.1001-20.2401 within 30 days following any planned special exposure conducted in accordance with § 20.1206, informing the Commission that a planned special exposure was conducted and indicating the date the planned special exposure occurred and the information required by § 20.2105.

§ 20.2205 (Reserved)

§ 20.2206 Reports of individual monitoring.

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

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

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

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

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

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

(6) Receive radioactive waste from other persons for disposal under part 61 of this chapter; or

(7) Possess or use at any time, for processing or manufacturing for distribution pursuant to parts 30, 32, 33 or 35 of this chapter, byproduct material in quantities exceeding any one of the following quantities:

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

¹ The Commission may require as a license condition, or by rule, regulation, or order pursuant to § 20.2302, reports from licensees who are licensed to use radionuclides not on this list in quantities sufficient to cause comparable radiation levels.

(b) Each licensee in a category listed in paragraph (a) of this section shall submit an annual report of the results of individual monitoring carried out by the licensee for each individual for whom monitoring was required by § 20.1502 during that year. The licensee may include additional data for individuals for whom monitoring was provided but not required. The licensee shall use Form NRC 5 or electronic media containing all the information required by Form NRC 5.

(c) The licensee shall file the report required by § 20.2206(b), covering the preceding year, on or before April 30 of each year. The licensee shall submit the report to the REIRS Project Manager, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

Subpart N—Exemptions and Additional Requirements

§ 20.2301 Applications for exemptions.

The Commission may, upon application by a licensee or upon its own initiative, grant an exemption from the requirements of the regulations in this part if it determines the exemption

is authorized by law and would not result in undue hazard to life or property.

§ 20.2302 Additional requirements.

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

Subpart O—Enforcement

§ 20.2401 Violations.

(a) The Commission may obtain an injunction or other court order to prevent a violation of the provisions of—

(1) The Atomic Energy Act of 1954, as amended;

(2) Title II of the Energy Reorganization Act of 1974, as amended; or

(3) A regulation or order issued pursuant to those Acts.

(b) The Commission may obtain a court order for the payment of a civil

penalty imposed under section 234 of the Atomic Energy Act:

(1) For violations of—

(i) Sections 53, 57, 62, 63, 81, 82, 101, 103, 104, 107 or 109 of the Atomic Energy Act of 1954, as amended;

(ii) Section 206 of the Energy Reorganization Act;

(iii) Any rule, regulation, or order issued pursuant to the sections specified in paragraph (b)(1)(i) of this section;

(iv) Any term, condition, or limitation of any license issued under the sections specified in paragraph (b)(1)(i) of this section.

(2) For any violation for which a license may be revoked under Section 186 of the Atomic Energy Act of 1954, as amended.

(c) Any person who willfully violates a provision of the Atomic Energy Act or regulation or order issued under the requirements of that Act may be guilty of a crime and, upon conviction, be punished by fine or imprisonment or both, as provided by law.

APPENDIX A TO §§ 20.1001—20.2401—PROTECTION FACTORS FOR RESPIRATORS*

Description ^a	Protection Factors ^a			Tested & Certified Equipment
	Modes ^b	Particulates only	Particulates, gases, & vapors ^c	
I. Air-Purifying Respirators: ^d				
Facepiece, half-mask ^e	NP	10	30 CFR Part 11, Subpart K.	
Facepiece, full	NP	50		
Facepiece, half-mask full, or hood	PP	1000		
II. Atmosphere-Supplying Respirators:				
1. Air-line respirator:				
Facepiece, half-mask	CF		1000	30 CFR Part 11, Subpart J.
Facepiece, half-mask	D		5	
Facepiece, full	CF		2000	
Facepiece, full	D		5	
Facepiece, full	PD		2000	
Hood	CF		(^f)	
Suit	CF		(^f) (^g)	
2. Self-contained breathing apparatus (SCBA):				
Facepiece, full	D		50	30 CFR Part 11, Subpart H.
Facepiece, full	PD		* 10,000	
Facepiece, full	RD		50	
Facepiece, full	RP		15,000	
III. Combination Respirators				
Any combination of air-purifying and atmosphere-supplying respirators		Protection factor for type and mode of operation as listed above.		30 CFR Part 11, § 11.63(b)

Footnotes

a. For use in the selection of respiratory protective devices to be used only where the contaminants have been identified and the concentrations (or possible concentrations) are known.

b. Only for shaven faces and where nothing interferes with the seal of tight-fitting facepieces against the skin. (Hoods and suits are excepted.)

c. The mode symbols are defined as follows:

CF = continuous flow

D = demand

NP = negative pressure (i.e., negative phase during inhalation)

PD = pressure demand (i.e., always positive pressure)

PP = positive pressure
 RD = demand, recirculating (closed circuit)
 RP = pressure demand, recirculating (closed circuit)

d 1 The protection factor is a measure of the degree of protection afforded by a respirator, defined as the ratio of the concentration of airborne radioactive material outside the respiratory protective equipment to that inside the equipment (usually inside the facepiece) under conditions of use. It is applied to the ambient airborne concentration to estimate the concentrations inhaled by the wearer according to the following formula:

$$\text{Concentration inhaled} = \frac{\text{Ambient airborne concentration}}{\text{Protection factor}}$$

2. The protection factors apply:

(a) Only for individuals trained in using respirators and wearing properly fitted respirators that are used and maintained under supervision in a well-planned respiratory protective program.

(b) For air-purifying respirators only when high efficiency particulate filters (above 99.97% removal efficiency by thermally generated 0.3 μm dioctyl phthalate (DOP) test or equivalent) are used in atmospheres not deficient in oxygen and not containing radioactive gas or vapor respiratory hazards.

(c) No adjustment is to be made for the use of sorbents against radioactive material in the form of gases or vapors.

(d) For atmosphere-supplying respirators only when supplied with adequate respirable air. Respirable air shall be provided of the quality and quantity required in accordance with NIOSH/MSHA certification (described in 30 CFR part 11). Oxygen and air shall not be used in the same apparatus.

e. Excluding radioactive contaminants that present an absorption or submersion hazard. For tritium oxide, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of less than 2 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. If the protection factor for a device is 5 the effective protection factor for tritium is about 1.4; for devices with protection factors of 10 the effective factor for tritium oxide is about 1.7, and for devices with protection factors of 100 or more the effective factor for tritium oxide is about 1.9. Air-purifying respirators are not suitable for protection against tritium oxide. See also footnote i concerning supplied-air suits.

f. Canisters and cartridges shall not be used beyond service-life limitations.

g. Under-chin type only. This type of respirator is not satisfactory for use where it might be possible (e.g., if an accident or emergency were to occur) for the ambient airborne concentrations to reach instantaneous values greater than 10 times the pertinent values in table 1, column 3 of appendix B to §§ 20.1001--20.2401 of this part. This type of respirator is not suitable for protection against plutonium or other high-toxicity materials. The mask is to be tested for fit prior to use, each time it is donned.

h.1. Equipment shall be operated in a manner that ensures that proper air flow-rates are maintained. A protection factor of no more than 1000 may be utilized for tested-and-certified supplied-air hoods when a minimum air flow of 6 cubic feet (0.17 cubic meters) per minute is maintained and

calibrated air-line pressure gauges or flow measuring devices are used. A protection factor of up to 2000 may be used for tested and certified hoods only when the air flow is maintained at the manufacturer's recommended maximum rate for the equipment, this rate is greater than 6 cubic feet (0.17 cubic meters) per minute, and calibrated air-line pressure gauges or flow measuring devices are used.

2. The design of the supplied-air hood or helmet (with a minimum flow of 8 cfm (0.17 m³ per minute) of air) may determine its overall efficiency and the protection it provides. For example, some hoods aspirate contaminated air into the breathing zone when the wearer works with hands-over-head. This aspiration may be overcome if a short cape-like extension to the hood is worn under a coat or overalls. Other limitations specified by the approval agency shall be considered before using a hood in certain types of atmospheres (see footnote i).

i. Appropriate protection factors shall be determined, taking into account the design of the suit and its permeability to the contaminant under conditions of use. There shall be a standby rescue person equipped with a respirator or other apparatus appropriate for the potential hazards and communications equipment whenever supplied-air suits are used.

j. No approval schedules are currently available for this equipment. Equipment is to be evaluated by testing or on the basis of reliable test information.

k. This type of respirator may provide greater protection and be used as an emergency device in unknown concentrations for protection against inhalation hazards. External radiation hazards and other limitations to permitted exposure, such as skin absorption, must be taken into account in such circumstances.

l. Quantitative fit testing shall be performed on each individual and no more than 0.02% leakage is allowed with this type of apparatus. Perceptible outward leakage of gas from this or any positive pressure self-contained breathing apparatus is unacceptable because service life will be reduced substantially. Special training in the use of this type of apparatus shall be provided to the wearer.

Note 1: Protection factors for respirators as may be approved by the U.S. Bureau of Mines/National Institute for Occupational Safety and Health (NIOSH), according to applicable approvals for respirators for type and mode of use to protect against airborne radionuclides, may be used to the extent that

they do not exceed the protection factors listed in this table. The protection factors listed in this table may not be appropriate to circumstances where chemical or other respiratory hazards exist in addition to radioactive hazards. The selection and use of respirators for such circumstances should take into account applicable approvals of the U.S. Bureau of Mines/NIOSH.

Note 2: Radioactive contaminants for which the concentration values in Table 1, Column 3 of Appendix B to §§ 20.1001--20.2401 of this part are based on internal dose due to inhalation may, in addition, present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.

Appendix B to §§ 20.1001--20.2401— Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage

Introduction

For each radionuclide Table 1 indicates the chemical form which is to be used for selecting the appropriate ALI or DAC value. The ALIs and DACs for inhalation are given for an aerosol with an activity median aerodynamic diameter (AMAD) of 1 μm and for three classes (D,W,Y) of radioactive material, which refer to their retention (approximately days, weeks or years) in the pulmonary region of the lung. This classification applies to a range of clearance half-times of less than 10 days, for W from 10 to 100 days, and for Y greater than 100 days. Table 2 provides concentration limits for airborne and liquid effluents released to the general environment. Table 3 provides concentration limits for discharges to sanitary sewer systems.

Notation

The values in Tables 1, 2, and 3 are presented in the computer "E" notation. In this notation a value of 6E-02 represents a value of 6×10^{-2} or 0.06. 6E+2 represents 6×10^2 or 600, and 6E+0 represents 6×10^0 or 6.

Table 1 "Occupational"

Note that the columns in Table 1, of this appendix captioned "Oral Ingestion ALI,"

"Inhalation ALI" and "DAC" are applicable to occupational exposure to radioactive material.

The ALIs in this appendix are the annual intakes of a given radionuclide by "Reference Man" which would result in either (1) a committed effective dose equivalent of 5 rema (stochastic ALI) or (2) a committed dose equivalent of 50 rema to an organ or tissue (non-stochastic ALI). The stochastic ALIs were derived to result in a risk, due to irradiation of organs and tissues, comparable to the risk associated with deep dose equivalent to the whole body of 5 rema. The derivation includes multiplying the committed dose equivalent to an organ or tissue by a weighting factor, w_T . This weighting factor is the proportion of the risk of stochastic effects resulting from irradiation of the organ or tissue, T , to the total risk of stochastic effects when the whole body is irradiated uniformly. The values of w_T are listed under the definition of weighting factor in § 20.1003. The non-stochastic ALIs were derived to avoid non-stochastic effects, such as prompt damage to tissue or reduction in organ function.

A value of $w_T = 0.06$ is applicable to each of the five organs or tissues in the "remainder" category receiving the highest dose equivalents, and the dose equivalents of all other remaining tissues may be disregarded. The following parts of the GI tract—stomach, small intestine, upper large intestine, and lower large intestine—are to be treated as four separate organs.

Note that the dose equivalents for extremities (hands and forearms, feet and lower legs), skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.

When an ALI is defined by the stochastic dose limit, this value alone is given. When an ALI is determined by the non-stochastic dose limit to an organ, the organ or tissue to which the limit applies is shown, and the ALI for the stochastic limit is shown in parentheses. (Abbreviated organ or tissue designations are used: L.I. wall = lower large intestine wall; St. wall = stomach wall; Blad wall = bladder wall; and Bone surf = bone surface.)

The use of the ALIs listed first, the more limiting of the stochastic and non-stochastic ALIs, will ensure that non-stochastic effects are avoided and that the risk of stochastic effects is limited to an acceptably low value. If, in a particular situation involving a radionuclide for which the non-stochastic ALI is limiting, use of that non-stochastic ALI is considered unduly conservative, the licensee may use the stochastic ALI to determine the committed effective dose equivalent. However, the licensee shall also ensure that the 50-rem dose equivalent limit for any organ or tissue is not exceeded by the sum of the external deep dose equivalent plus the internal committed dose to that organ (not the effective dose). For the case where there is no external dose contribution, this would be demonstrated if the sum of the fractions of the nonstochastic ALIs (ALI_{ns}/ALI_{st}) that contribute to the committed dose equivalent to the organ receiving the highest dose does not exceed unity (i.e., Σ (intake (in μ Cl) of each radionuclide/ ALI_{ns}) < 1.0). If there is an

external deep dose equivalent contribution of H_d , then this sum must be less than $1 - (H_d/50)$ instead of being < 1.0 .

Note that the dose equivalents for extremities (hand and forearms, feet and lower legs), skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.

The derived air concentration (DAC) values are derived limits intended to control chronic occupational exposures. The relationship between the DAC and the ALI is given by: $DAC = ALI(\text{in } \mu\text{Ci}) / (2000 \text{ hours per working year} \times 60 \text{ minutes/hour} \times 2 \times 10^4 \text{ ml per minute}) = [ALI/2.4 \times 10^7] \mu\text{Ci/ml}$, where $2 \times 10^4 \text{ ml}$ is the volume of air breathed per minute at work by "Reference Man" under working conditions of "light work."

The DAC values relate to one of two modes of exposure: either external submersion or the internal committed dose equivalents resulting from inhalation of radioactive materials. Derived air concentrations based upon submersion are for immersion in a semi-infinite cloud of uniform concentration and apply to each radionuclide separately.

The ALI and DAC values relate to exposure to the single radionuclide named, but also include contributions from the ingrowth of any daughter radionuclide produced in the body by the decay of the parent. However, intakes that include both the parent and daughter radionuclides should be treated by the general method appropriate for mixtures.

The value of ALI and DAC do not apply directly when the individual both ingests and inhales a radionuclide, when the individual is exposed to a mixture of radionuclides by either inhalation or ingestion or both, or when the individual is exposed to both internal and external radiation (see § 20.1202). When an individual is exposed to radioactive materials which fall under several of the translocation classifications (i.e., Class D, Class W, or Class Y) of the same radionuclide, the exposure may be evaluated as if it were a mixture of different radionuclides.

It should be noted that the classification of a compound as Class D, W, or Y is based on the chemical form of the compound and does not take into account the radiological half-life of different radioisotopes. For this reason, values are given for Class D, W, and Y compounds, even for very short-lived radionuclides.

Table 2

The columns in Table 2 of this appendix captioned "Effluents," "Air," and "Water," are applicable to the assessment and control of dose to the public, particularly in the implementation of the provisions of § 20.1302. The concentration values given in Columns 1 and 2 of Table 2 are equivalent to the radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent of 0.05 rem (50 millirem or 0.5 millisieverts).

Consideration of non-stochastic limits has not been included in deriving the air and water effluent concentration limits because non-stochastic effects are presumed not to

occur at the dose levels established for individual members of the public. For radionuclides, where the non-stochastic limit was governing in deriving the occupational DAC, the stochastic ALI was used in deriving the corresponding airborne effluent limit in Table 2. For this reason, the DAC and airborne effluent limits are not always proportional as was the case in appendix B to §§ 20.1-20.601.

The air concentration values listed in Table 2, Column 1, were derived by one of two methods. For those radionuclides for which the stochastic limit is governing, the occupational stochastic inhalation ALI was divided by 2.4×10^7 , relating the inhalation ALI to the DAC, as explained above, and then divided by a factor of 300. The factor of 300 includes the following components: a factor of 50 to relate the 5-rem annual occupational dose limit to the 0.1-rem limit for members of the public, a factor of 3 to adjust for the difference in exposure time and the inhalation rate for a worker and that for members of the public; and a factor of 2 to adjust the occupational values (derived for adults) so that they are applicable to other age groups.

For those radionuclides for which submersion (external dose) is limiting, the occupational DAC in Table 1, Column 3, was divided by 219. The factor of 219 is composed of a factor of 50, as described above, and a factor of 4.38 relating occupational exposure for 2,000 hours per year to full-time exposure (8,760 hours per year). Note that an additional factor of 2 for age considerations is not warranted in the submersion case.

The water concentrations were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^3 . The factor of 7.3×10^3 (ml) includes the following components: the factors of 50 and 2 described above and a factor of 7.3×10^3 (ml) which is the annual water intake of "Reference Man."

Note 2 of this appendix provides groupings of radionuclides which are applicable to unknown mixtures of radionuclides. These groupings (including occupational inhalation ALIs and DACs, air and water effluent concentrations and sewerage) require demonstrating that the most limiting radionuclides in successive classes are absent. The limit for the unknown mixture is defined when the presence of the one of the listed radionuclides cannot be definitely excluded as being present either from knowledge of the radionuclide composition of the source or from actual measurements.

Table 3 "Sewer Disposal"

The monthly average concentrations for release to sanitary sewers are applicable to the provisions in § 20.2003. The concentration values were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^3 (ml). The factor of 7.3×10^3 (ml) is composed of a factor of 7.3×10^3 (ml), the annual water intake by "Reference Man," and a factor of 10, such that the concentrations, if the sewage released by the licensee were the only source of water ingested by a reference man during a year, would result in a

committed effective dose equivalent of 0.5 rem.

LIST OF ELEMENTS

Name	Atomic	
	Symbol	No.
Actinium	Ac	89
Aluminum	Al	13
Americium	Am	95
Antimony	Sb	51
Argon	Ar	18
Arsenic	As	33
Astatine	At	85
Barium	Ba	56
Berkelium	Bk	97
Beryllium	Be	4
Bismuth	Bi	83
Bromine	Br	35
Cadmium	Cd	48
Calcium	Ca	20
Californium	Cf	98
Carbon	C	6
Cerium	Ce	58
Cesium	Cs	55
Chlorine	Cl	17
Chromium	Cr	24
Cobalt	Co	27
Copper	Cu	29
Cunum	Cm	96
Dysprosium	Dy	66
Einsteinium	Es	99
Erbium	Er	68
Europium	Eu	63
Fermium	Fm	100
Fluorine	F	9
Francium	Fr	87
Gadolinium	Gd	64

LIST OF ELEMENTS—Continued

Name	Atomic	
	Symbol	No.
Gallium	Ga	31
Germanium	Ge	32
Gold	Au	79
Hafnium	Hf	72
Holmium	Ho	67
Hydrogen	H	1
Indium	In	49
Iodine	I	53
Indium	Ir	77
Iron	Fe	26
Krypton	Kr	36
Lanthanum	La	57
Lead	Pb	82
Lutetium	Lu	71
Magnesium	Mg	12
Manganese	Mn	25
Mendelevium	Md	101
Mercury	Hg	80
Molybdenum	Mo	42
Neodymium	Nd	60
Neptunium	Np	93
Nickel	Ni	28
Niobium	Nb	41
Osmium	Os	76
Palladium	Pd	46
Phosphorus	P	15
Platinum	Pt	78
Plutonium	Pu	94
Polonium	Po	84
Potassium	K	19
Praseodymium	Pr	59
Promethium	Pm	61
Protactinium	Pa	91
Radium	Ra	88

LIST OF ELEMENTS—Continued

Name	Atomic	
	Symbol	No.
Radon	Rn	86
Rhenium	Re	75
Rhodium	Rh	45
Rubidium	Rb	37
Ruthenium	Ru	44
Samarium	Sm	62
Scandium	Sc	21
Selenium	Se	34
Silicon	Si	14
Silver	Ag	47
Sodium	Na	11
Strontium	Sr	38
Sulfur	S	16
Tantalum	Ta	73
Technetium	Tc	43
Tellurium	Te	52
Terbium	Tb	65
Thallium	Tl	81
Thorium	Th	90
Thalium	Tm	69
Tin	Sn	50
Titanium	Ti	22
Tungsten	W	74
Uranium	U	92
Vanadium	V	23
Xenon	Xe	54
Ytterbium	Yb	70
Yttrium	Y	39
Zinc	Zn	30
Zirconium	Zr	40

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
			Oral Ingestion ALI (μCi)	Inhalation ALI (DAC) ($\mu\text{Ci}/\text{ml}$)		Air ($\mu\text{Ci}/\text{ml}$)	Water ($\mu\text{Ci}/\text{ml}$)	
1	Hydrogen-3	Water, DAC includes skin absorption Gas (HT or T ₂) Submersion ¹ : Use above values as HT and T ₂ oxidize in air and in the body to HTQ.	8E+4	8E+4	2E-5	1E-7	1E-3	1E-2
4	Beryllium-7	W, all compounds except those given for Y Y, oxides, halides, and nitrates	4E+4	2E+4	9E-6	3E-8	6E-4	6E-3
4	Beryllium-10	W, see ⁷ Be Y, see ⁷ Be	1E+3 (LLI wall) (1E+3)	2E+2 1E+1	6E-8 6E-9	2E-10 2E-11	- 2E-5	- 2E-4
6	Carbon-11 ²	Monoxide Dioxide Compounds	- - 4E+5	1E+6 6E+5 4E+5	5E-4 3E-4 2E-4	2E-6 9E-7 6E-7	- - 6E-3	- - 6E-2
6	Carbon-14	Monoxide Dioxide Compounds	- - 2E+3	2E+6 2E+5 2E+3	7E-4 9E-5 1E-6	2E-6 3E-7 3E-9	- - 3E-5	- - 3E-4
9	Fluorine-18 ²	D, fluorides of H, Li, Na, K, Rb, Cs, and Fr W, fluorides of Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, As, Sb, Bi, Fe, Ru, Os, Co, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, V, Nb, Ta, Mn, Tc, and Re Y, lanthanum fluoride	5E+4 St wall (5E+4)	7E+4 -	3E-5 -	1E-7 -	- 7E-4	- 7E-3
11	Sodium-22	D, all compounds	4E+2	6E+2	3E-7	9E-10	6E-6	6E-5
11	Sodium-24	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
12	Magnesium-28	D, all compounds except those given for W W, oxides, hydroxides, carbides, halides, and nitrates	7E+2 -	2E+3 1E+3	7E-7 5E-7	2E-9 2E-9	9E-6 -	9E-5 -
13	Aluminum-26	D, all compounds except those given for W W, oxides, hydroxides, carbides, halides, and nitrates	4E+2 -	6E+1 9E+1	3E-8 4E-8	9E-11 1E-10	6E-6 -	6E-5 -

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μ Ci)	Col. 2		Col. 1 Air (μ Ci/ml)	Col. 2 Water (μ Ci/ml)	Monthly Average Concentration (μ Ci/ml)
				Inhalation				
				ALI (μ Ci)	OAC (μ Ci/ml)			
14	Silicon-31	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and nitrates	-	3E+4	1E-5	5E-8	-	-
		Y, aluminosilicate glass	-	3E+4	1E-5	4E-8	-	-
14	Silicon-32	D, see ^{31}Si	2E+3 LLI wall (3E+3)	2E+2	1E-7	3E-10	-	-
		W, see ^{31}Si	-	1E+2	5E-8	2E-10	4E-5	4E-4
		Y, see ^{31}Si	-	5E+0	2E-9	7E-12	-	-
15	Phosphorus-32	D, all compounds except phosphates given for W	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
		W, phosphates of Zn^{2+} , S^{2+} , Mg^{2+} , Fe^{3+} , Bi^{3+} , and lanthanides	-	4E+2	2E-7	5E-10	-	-
15	Phosphorus-33	D, see ^{32}P	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4
		W, see ^{32}P	-	3E+3	1E-6	4E-9	-	-
16	Sulfur-35	Vapor	-	1E+4	6E-6	2E-8	-	-
		D, sulfides and sulfates except those given for W	1E+4 LLI wall (8E+3)	2E+4	7E-6	2E-8	-	-
		W, elemental sulfur, sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, and Mo; Sulfates of Ca, Sr, Ba, Ra, As, Sb, and Bi	6E+3	-	-	-	1E-4	1E-3
		W, chlorides of H, Li, Na, K, Rb, Cs, and Fr	-	2E+3	9E-7	3E-9	-	-
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, chlorides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, and Re	-	2E+2	1E-7	3E-10	-	-

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
17	Chlorine-36 ²	D, see ³⁶ Cl	2E+4 St. wall (3E+4)	4E+4	2E-5	6E-8	-	-
		W, see ³⁶ Cl	-	5E+4	2E-5	6E-8	3E-4	3E-3
17	Chlorine-39 ²	D, see ³⁶ Cl	2E+4 St. wall (4E+4)	5E+4	2E-5	7E-8	-	-
		W, see ³⁶ Cl	-	5E+4	2E-5	8E-8	5E-4	5E-3
18	Argon-37	Submersion ¹	-	-	1E+0	6E-3	-	-
18	Argon-39	Submersion ¹	-	-	2E-4	8E-7	-	-
18	Argon-41	Submersion ¹	-	-	3E-6	1E-8	-	-
19	Potassium-40	D, all compounds	3E+2	4E+2	2E-7	6E-10	4E-6	4E-5
19	Potassium-42	D, all compounds	5E+3	5E+3	2E-6	7E-9	6E-5	5E-4
19	Potassium-43	D, all compounds	6E+3	9E+3	4E-6	1E-8	9E-5	9E-4
19	Potassium-44 ²	D, all compounds	2E+4 St. wall (4E+4)	7E+4	3E-5	9E-8	-	-
			-	-	-	-	5E-4	5E-3
19	Potassium-45 ²	D, all compounds	3E+4 St. wall (5E+4)	1E+5	5E-5	2E-7	-	-
			-	-	-	-	7E-4	7E-3
20	Calcium-41	W, all compounds	3E+3 Bone surf (4E+3)	4E+3 Bone surf (4E+3)	2E-6	-	-	-
			-	-	-	5E-9	6E-5	6E-4
20	Calcium-45	W, all compounds	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
20	Calcium-47	W, all compounds	8E+2	9E+2	4E-7	1E-9	1E-5	1E-4
21	Scandium-43	Y, all compounds	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
21	Scandium-44a	Y, all compounds	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
21	Scandium-44	Y, all compounds	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
21	Scandium-46	Y, all compounds	9E+2	2E+2	1E-7	3E-10	1E-5	1E-4
21	Scandium-47	Y, all compounds	2E+3 LLI wall (3E+3)	3E+3	1E-6	4E-9	-	-
			-	-	-	-	4E-5	4E-4
21	Scandium-48	Y, all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
21	Scandium-49 ²	Y, all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
22	Titanium-44	D, all compounds except those given for W and Y	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	3E-1	1E-8	4E-11	-	-
		Y, 5rTiO ₃	-	6E+0	2E-9	8E-12	-	-

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
			Oral Ingestion, ALI (μCi)	Inhalation		Air ($\mu\text{Ci}/\text{ml}$)	Water ($\mu\text{Ci}/\text{ml}$)	
				ALI (μCi)	DAC ($\mu\text{Ci}/\text{ml}$)			
22	Titanium-45	D, see 44Ti W, see 44Ti Y, see 44Ti	9E+3	3E+4	1E-5	3E-8	1E-4	1E-3
			-	4E+4	1E-5	5E-8	-	-
			-	3E+4	1E-5	4E-8	-	-
23	Vanadium-47 ²	D, all compounds except those given for W	3E+4 St. wall (3E+4)	8E+4	3E-5	1E-7	-	-
			-	-	-	-	4E-4	4E-3
		W, oxides, hydroxides, carbides, and halides	-	1E+5	4E-5	1E-7	-	-
23	Vanadium-48	D, see 47V W, see 47V	6E+2	1E+3	5E-7	2E-9	9E-5	9E-5
			-	6E+2	3E-7	9E-10	-	-
23	Vanadium-49	D, see 47V	7E+4	3E+4	1E-5	-	-	-
			LLI wall (9E+4)	Bone surf (3E+4)	-	5E-8	1E-3	1E-2
		W, see 47V	-	2E+4	8E-6	2E-8	-	-
24	Chromium-48	D, all compounds except those given for W and Y	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, halides and nitrates	-	7E+3	3E-6	1E-8	-	-
		Y, oxides and hydroxides	-	7E+3	3E-6	1E-8	-	-
24	Chromium-49 ²	D, see 48Cr W, see 48Cr Y, see 48Cr	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
			-	1E+5	4E-5	1E-7	-	-
			-	9E+4	4E-5	1E-7	-	-
24	Chromium-51	D, see 48Cr W, see 48Cr Y, see 48Cr	4E+4	5E+4	2E-5	6E-8	5E-4	5E-3
			-	2E+4	1E-5	3E-8	-	-
			-	2E+4	8E-6	3E-8	-	-
25	Manganese-51 ²	D, all compounds except those given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	8E-8	-	-
25	Manganese-52m ²	D, see 51Mn	3E+4 St. wall (4E+4)	9E+4	4E-5	1E-7	-	-
			-	-	-	-	5E-4	5E-3
		W, see 51Mn	-	1E+5	4E-5	1E-7	-	-
25	Manganese-52	D, see 51Mn W, see 51Mn	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
			-	9E+2	4E-7	1E-9	-	-
25	Manganese-53	D, see 51Mn	5E+4	1E+4	5E-6	-	7E-4	7E-3
			-	Bone surf (2E+4)	-	3E-8	-	-
		W, see 51Mn	-	1E+4	5E-6	2E-8	-	-
25	Manganese-54	D, see 51Mn W, see 51Mn	2E+3	9E+2	4E-7	1E-9	3E-5	3E-4
			-	8E+2	3E-7	1E-9	-	-
25	Manganese-56	D, see 51Mn W, see 51Mn	5E+3	2E+4	6E-7	2E-8	7E-5	7E-4
			-	2E+4	9E-5	3E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)	Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
26	Iron-52	D, all compounds except those given for W	9E+2	3E+3	1E-6	4E-9	1E-5	1E-4
		W, oxides, hydroxides, and halides	-	2E+3	1E-6	3E-9	-	-
26	Iron-55	D, see ^{52}Fe W, see ^{52}Fe	9E+3 -	2E+3 4E+3	8E-7 2E-6	3E-9 6E-9	1E-4 -	1E-3 -
26	Iron-59	D, see ^{52}Fe W, see ^{52}Fe	8E+2 -	3E+2 5E+2	1E-7 2E-7	5E-10 7E-10	1E-5 -	1E-4 -
26	Iron-60	D, see ^{52}Fe W, see ^{52}Fe	3E+1 -	6E+0 2E+1	3E-9 8E-9	9E-12 3E-11	4E-7 -	4E-6 -
27	Cobalt-55	W, all compounds except those given for Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
27	Cobalt-56	W, see ^{55}Co Y, see ^{55}Co	5E+2 4E+2	3E+2 2E+2	1E-7 8E-8	4E-10 3E-10	6E-6 -	6E-5 -
27	Cobalt-57	W, see ^{55}Co Y, see ^{55}Co	8E+3 4E+3	3E+3 7E+2	1E-6 3E-7	4E-9 9E-10	6E-5 -	5E-4 -
27	Cobalt-58m	W, see ^{55}Co Y, see ^{55}Co	6E+4 -	9E+4 6E+4	4E-5 3E-5	1E-7 5E-8	8E-4 -	8E-3 -
27	Cobalt-58	W, see ^{55}Co Y, see ^{55}Co	2E+3 1E+3	1E+3 7E+2	5E-7 3E-7	2E-9 1E-9	2E-5 -	2E-4 -
27	Cobalt-60m ²	W, see ^{55}Co	1E+6	4E+6	2E-3	6E-6	-	-
		St. wall (1E+6)	-	-	-	-	2E-2	2E-1
		Y, see ^{55}Co	-	3E+6	1E-3	4E-6	-	-
27	Cobalt-60	W, see ^{55}Co Y, see ^{55}Co	5E+2 2E+2	2E+2 3E+1	7E-8 1E-8	2E-10 5E-11	3E-6 -	3E-5 -
27	Cobalt-61 ²	W, see ^{55}Co Y, see ^{55}Co	2E+4 2E+4	6E+4 6E+4	3E-5 2E-5	9E-8 8E-8	3E-4 -	3E-3 -
27	Cobalt-62m ²	W, see ^{55}Co	4E+4	2E+5	7E-5	2E-7	-	-
		St. wall (5E+4)	-	-	-	-	7E-4	7E-3
		Y, see ^{55}Co	-	2E+5	6E-5	2E-7	-	-
28	Nickel-56	D, all compounds except those given for W	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		W, oxides, hydroxides, and carbides	-	1E+3	5E-7	2E-9	-	-
		Vapor	-	1E+3	5E-7	2E-9	-	-
28	Nickel-57	D, see ^{56}Ni W, see ^{56}Ni Vapor	2E+3 - -	5E+3 3E+3 6E+3	2E-6 1E-6 3E-6	7E-8 4E-9 9E-9	2E-5 - -	2E-4 - -

Atomic—Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
		Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Col. 3		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
			Inhalation				
			Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
28	Nickel-59	D, see ^{56}Ni W, see ^{56}Ni Vapor	2E+4 - -	4E+3 7E+3 2E+3	2E-6 3E-6 8E-7	5E-9 1E-8 3E-9	3E-4 - -
28	Nickel-63	D, see ^{56}Ni W, see ^{56}Ni Vapor	9E+3 - -	2E+3 3E+3 8E+2	7E-7 1E-6 3E-7	2E-9 4E-9 1E-9	1E-4 - -
28	Nickel-65	D, see ^{56}Ni W, see ^{56}Ni Vapor	8E+3 - -	2E+4 3E+4 2E+4	1E-5 1E-5 7E-6	3E-8 4E-8 2E-8	1E-4 - -
28	Nickel-66	D, see ^{56}Ni W, see ^{56}Ni Vapor	4E+2 (5E+2) -	2E+3 - 6E+2 3E+3	7E-7 - 3E-7 1E-6	2E-9 - 9E-10 4E-9	- 6E-6 -
29	Copper-60 ²	D, all compounds except those given for W and Y W, sulfides, halides, and nitrates Y, oxides and hydroxides	3E+4 (3E+4) -	9E+4 - 1E+5	4E-5 - 5E-5	1E-7 - 2E-7	- 4E-4 -
29	Copper-61	D, see ^{60}Cu W, see ^{60}Cu Y, see ^{60}Cu	1E+4 - -	3E+4 4E+4 4E+4	1E-5 2E-5 1E-5	4E-8 6E-8 5E-8	2E-4 - -
29	Copper-64	D, see ^{60}Cu W, see ^{60}Cu Y, see ^{60}Cu	1E+4 - -	3E+4 2E+4 2E+4	1E-5 1E-5 9E-6	4E-8 3E-8 3E-8	2E-4 - -
29	Copper-67	D, see ^{60}Cu W, see ^{60}Cu Y, see ^{60}Cu	5E+3 - -	8E+3 5E+3 5E+3	3E-5 2E-6 2E-6	1E-8 7E-9 6E-9	6E-5 - -
30	Zinc-62	Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5
30	Zinc-63 ²	Y, all compounds	2E+4 (3E+4) -	7E+4 - -	3E-5 - -	9E-8 -	- 3E-4
30	Zinc-65	Y, all compounds	4E+2	3E+2	1E-7	4E-10	5E-6
30	Zinc-69m	Y, all compounds	4E+3	7E+3	3E-6	1E-8	6E-5
30	Zinc-69 ²	Y, all compounds	6E+4	1E+5	6E-5	2E-7	8E-4
30	Zinc-71m	Y, all compounds	6E+3	2E+4	7E-6	2E-8	8E-5
30	Zinc-72	Y, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5
31	Gallium-65 ²	D, all compounds except those given for W W, oxides, hydroxides, carbides, halides, and nitrates	5E+4 (6E+4) -	2E+5 - 2E+5	7E-5 - 8E-5	2E-7 - 3E-7	- 9E-4 -

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
			Col. 1 Oral Ingestion AI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)	
				AI (μCi)	DAC				
31	Gallium-66	D, see ^{66}Ga W, see ^{66}Ga	$1\text{E}+3$ -	$4\text{E}+3$ $2\text{E}+3$	$1\text{E}-6$ $1\text{E}-6$	$5\text{E}-9$ $4\text{E}-9$	$1\text{E}-5$ -	$1\text{E}-4$ -	
31	Gallium-67	D, see ^{67}Ga W, see ^{67}Ga	$7\text{E}+3$ -	$1\text{E}+4$ $1\text{E}+4$	$6\text{E}-6$ $4\text{E}-6$	$2\text{E}-8$ $1\text{E}-8$	$1\text{E}-4$ -	$1\text{E}-3$ -	
31	Gallium-68 ²	D, see ^{68}Ga W, see ^{68}Ga	$2\text{E}+4$ -	$4\text{E}+4$ $5\text{E}+4$	$2\text{E}-5$ $1\text{E}-5$	$6\text{E}-8$ $7\text{E}-8$	$2\text{E}-4$ -	$2\text{E}-3$ -	
31	Gallium-70 ²	D, see ^{70}Ga W, see ^{70}Ga	$5\text{E}+4$ St. wall ($7\text{E}+4$)	$2\text{E}+5$ -	$7\text{E}-5$ -	$2\text{E}-7$ -	- $1\text{E}-3$	- $1\text{E}-2$	
31	Gallium-72	D, see ^{72}Ga W, see ^{72}Ga	$1\text{E}+3$ -	$4\text{E}+3$ $1\text{E}+3$	$1\text{E}-6$ $1\text{E}-6$	$5\text{E}-9$ $4\text{E}-9$	$2\text{E}-5$ -	$2\text{E}-4$ -	
31	Gallium-73	D, see ^{73}Ga W, see ^{73}Ga	$5\text{E}+3$ -	$2\text{E}+4$ $2\text{E}+4$	$6\text{E}-6$ $6\text{E}-6$	$2\text{E}-8$ $2\text{E}-8$	$7\text{E}-5$ -	$7\text{E}-4$ -	
32	Germanium-66	D, all compounds except those given for W W, oxides, sulfides, and halides	$2\text{E}+4$ -	$3\text{E}+4$ $2\text{E}+4$	$1\text{E}-5$ $8\text{E}-6$	$4\text{E}-8$ $3\text{E}-8$	$3\text{E}-4$ -	$3\text{E}-3$ -	
32	Germanium-67 ⁴	D, see ^{67}Ge W, see ^{67}Ge	$3\text{E}+4$ St. wall ($4\text{E}+4$)	$9\text{E}+4$ -	$4\text{E}-5$ -	$1\text{E}-7$ -	- $6\text{E}-4$	- $6\text{E}-3$	
32	Germanium-68	D, see ^{68}Ge W, see ^{68}Ge	$5\text{E}+3$ -	$4\text{E}+3$ $1\text{E}+2$	$2\text{E}-6$ $4\text{E}-8$	$5\text{E}-9$ $1\text{E}-10$	$6\text{E}-5$ -	$6\text{E}-4$ -	
32	Germanium-69	D, see ^{69}Ge W, see ^{69}Ge	$1\text{E}+4$ -	$2\text{E}+4$ $8\text{E}+3$	$6\text{E}-6$ $3\text{E}-6$	$2\text{E}-8$ $1\text{E}-8$	$2\text{E}-4$ -	$2\text{E}-3$ -	
32	Germanium-71	D, see ^{71}Ge W, see ^{71}Ge	$5\text{E}+5$ -	$4\text{E}+5$ $4\text{E}+4$	$2\text{E}-4$ $2\text{E}-5$	$6\text{E}-7$ $6\text{E}-8$	$7\text{E}-3$ -	$7\text{E}-2$ -	
32	Germanium-75 ²	D, see ^{75}Ge W, see ^{75}Ge	$4\text{E}+4$ St. wall ($7\text{E}+4$)	$8\text{E}+4$ -	$3\text{E}-5$ -	$1\text{E}-7$ -	- $9\text{E}-4$	- $9\text{E}-3$	
32	Germanium-77	D, see ^{77}Ge W, see ^{77}Ge	$9\text{E}+3$ -	$1\text{E}+4$ $6\text{E}+3$	$4\text{E}-6$ $2\text{E}-6$	$1\text{E}-8$ $8\text{E}-9$	$1\text{E}-4$ -	$1\text{E}-3$ -	
32	Germanium-78 ²	D, see ^{78}Ge W, see ^{78}Ge	$2\text{E}+4$ St. wall ($2\text{E}+4$)	$2\text{E}+4$ -	$9\text{E}-6$ -	$3\text{E}-8$ -	- $3\text{E}-4$	- $3\text{E}-3$	

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Dose Ingestion AI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{Ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{Ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{Ml}$)
				Col. 2 AI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{Ml}$)			
33	Arsenic-59 ²	W, all compounds	3E+4 St. wall (4E+4)	1E+5	5E-5	2E-7	-	-
33	Arsenic-70 ²	W, all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3
33	Arsenic-71	W, all compounds	4E+3	5E+3	2E-6	6E-9	5E-5	5E-4
33	Arsenic-72	W, all compounds	9E+2	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-73	W, all compounds	8E+3	2E+3	7E-7	5E-9	1E-4	1E-3
33	Arsenic-74	W, all compounds	1E+3	8E+2	3E-7	1E-9	2E-5	2E-4
33	Arsenic-76	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-77	W, all compounds	4E+3 St. wall (5E+3)	5E+3	2E-6	7E-9	-	-
33	Arsenic-78 ²	W, all compounds	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
34	Selenium-70 ²	D, all compounds except those given for W W, oxides, hydroxides, carbides, and elemental Se	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
34	Selenium-73a ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	6E+4 3E+4	2E+5 1E+5	6E-5 6E-5	2E-7 2E-7	4E-4 -	4E-3 -
34	Selenium-73	D, see ⁷⁰ Se W, see ⁷⁰ Se	3E+3 -	1E+4 2E+4	5E-6 7E-6	2E-8 2E-8	4E-5 -	4E-4 -
34	Selenium-75	D, see ⁷⁰ Se W, see ⁷⁰ Se	5E+2 -	7E+2 6E+2	3E-7 3E-7	1E-9 8E-10	7E-6 -	7E-5 -
34	Selenium-79	D, see ⁷⁰ Se W, see ⁷⁰ Se	6E+2 -	8E+2 6E+2	3E-7 2E-7	1E-9 8E-10	8E-6 -	8E-5 -
34	Selenium-81a ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	4E+4 2E+4	7E+4 7E+4	3E-5 3E-5	9E-8 1E-7	3E-4 -	3E-3 -
34	Selenium-81 ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	6E+4 St. wall (8E+4)	2E+5 -	9E-5 -	3E-7 -	- 1E-3	- 1E-2
34	Selenium-83 ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	4E+4 3E+4	1E+5 1E+5	5E-5 5E-5	2E-7 2E-7	4E-4 -	4E-3 -

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
			Oral Ingestion ALI (μCi)	Inhalation		Air ($\mu\text{Ci}/\text{ml}$)	Water ($\mu\text{Ci}/\text{ml}$)	
				ALI (μCi)	DAC ($\mu\text{Ci}/\text{ml}$)			
35	Bromine-74 ²	D, bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4 St. wall (2E+4)	4E+4	2E-5	5E-8	-	-
		W, bromides of lantha- nides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Mn, Tc, and Re	-	4E+4	2E-5	6E-8	-	-
35	Bromine-74 ²	D, see ^{74m} Br	2E+4 St. wall (4E+4)	7E+4	3E-5	1E-7	-	-
		W, see ^{74m} Br	-	8E+4	4E-5	1E-7	5E-4	5E-3
35	Bromine-75 ²	D, see ^{74m} Br	3E+4 St. wall (4E+4)	5E+4	2E-5	7E-8	-	-
		W, see ^{74m} Br	-	5E+4	2E-5	7E-8	5E-4	5E-3
35	Bromine-76	D, see ^{74m} Br	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
		W, see ^{74m} Br	-	4E+3	2E-6	6E-9	-	-
35	Bromine-77	D, see ^{74m} Br	2E+4	2E+4	1E-5	3E-8	2E-4	2E-3
		W, see ^{74m} Br	-	2E+4	8E-6	3E-8	-	-
35	Bromine-80m	D, see ^{74m} Br	2E+4	2E+4	7E-6	2E-8	3E-4	3E-3
		W, see ^{74m} Br	-	1E+4	6E-6	2E-8	-	-
35	Bromine-80 ²	D, see ^{74m} Br	5E+4 St. wall (9E+4)	2E+5	8E-5	3E-7	-	-
		W, see ^{74m} Br	-	2E+5	9E-5	3E-7	1E-3	1E-2
35	Bromine-82	D, see ^{74m} Br	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{74m} Br	-	4E+3	2E-6	5E-9	-	-
35	Bromine-83	D, see ^{74m} Br	5E+4 St. wall (7E+4)	6E+4	3E-5	9E-8	-	-
		W, see ^{74m} Br	-	6E+4	3E-5	9E-8	9E-4	9E-3
35	Bromine-84 ²	D, see ^{74m} Br	2E+4 St. wall (3E+4)	6E+4	2E-5	8E-8	-	-
		W, see ^{74m} Br	-	6E+4	3E-5	9E-8	4E-4	4E-3
36	Krypton-74 ²	Submersion ¹	-	-	3E-6	1E-8	-	-
36	Krypton-76	Submersion ¹	-	-	9E-6	4E-8	-	-
36	Krypton-77 ²	Submersion ¹	-	-	4E-6	2E-8	-	-
36	Krypton-79	Submersion ¹	-	-	2E-5	7E-8	-	-
36	Krypton-81	Submersion ¹	-	-	7E-4	3E-6	-	-

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion All (μCi)	Col. 2 Inhalation		Col. 1 Air (μCi/m ³)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 All (μCi)	Col. 3 DAC (μCi/ml)			
36	Krypton-83m ²	Submersion ¹	-	-	1E-2	5E-5	-	-
36	Krypton-85m	Submersion ¹	-	-	2E-5	1E-7	-	-
36	Krypton-85	Submersion ¹	-	-	1E-4	7E-7	-	-
36	Krypton-87 ²	Submersion ¹	-	-	5E-6	2E-8	-	-
36	Krypton-88	Submersion ¹	-	-	2E-6	9E-9	-	-
37	Rubidium-79 ²	D, all compounds	4E+4 St. wall (6E+4)	1E+5	1E-5	2E-7	-	-
37	Rubidium-81m ²	D, all compounds	2E+5 St. wall (3E+5)	3E+5	1E-4	5E-7	-	-
37	Rubidium-81	D, all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
37	Rubidium-82m	D, all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3
37	Rubidium-83	D, all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5
37	Rubidium-84	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-86	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-87	D, all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
37	Rubidium-88 ²	D, all compounds	2E+4 St. wall (3E+4)	6E+4	3E-5	9E-8	-	-
37	Rubidium-89 ²	D, all compounds	4E+4 St. wall (6E+4)	1E+5	6E-5	2E-7	-	-
38	Strontium-80 ²	D, all soluble compounds except SrTiO ₃ Y, all insoluble compounds and SrTiO ₃	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
38	Strontium-81 ²	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	3E+4 2E+4	8E+4 8E+4	3E-5 3E-5	1E-7 1E-7	3E-4	3E-3
38	Strontium-82	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	3E+2 LLI wall (2E+2) 2E+2	4E+2	2E-7	6E-10	-	-
38	Strontium-83	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	3E+3 2E+3	7E+3 4E+3	3E-6 1E-6	1E-8 5E-9	3E-5	3E-4
38	Strontium-85m ²	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	2E+5	6E+5 8E+5	3E-4 4E-4	9E-7 1E-6	3E-3	3E-2
38	Strontium-85	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	3E+3	3E+3 2E+3	1E-6 6E-7	4E-9 2E-9	4E-5	4E-4
38	Strontium-87m	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	5E+4 4E+4	1E+5 2E+5	5E-5 6E-5	2E-7 2E-7	6E-4	6E-3

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radioisotope	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 All (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
38	Strontium-89	D, see ^{89}Sr	$6\text{E}+2$ LLI wall	$8\text{E}+2$	$4\text{E}+7$	$1\text{E}+9$	-	-
		Y, see ^{89}Sr	$(6\text{E}+2)$ $5\text{E}+2$	-	-	-	$8\text{E}+6$	$8\text{E}+5$
38	Strontium-90	D, see ^{90}Sr	$3\text{E}+1$ Bone surf	$2\text{E}+1$ Bone surf	$8\text{E}+9$	-	-	-
		Y, see ^{90}Sr	$(4\text{E}+1)$ -	$(2\text{E}+1)$ $4\text{E}+0$	-	$3\text{E}+11$ $6\text{E}+12$	$5\text{E}+7$	$5\text{E}+6$
38	Strontium-91	D, see ^{91}Sr	$2\text{E}+3$	$6\text{E}+3$	$2\text{E}+6$	$8\text{E}+9$	$2\text{E}+5$	$2\text{E}+4$
		Y, see ^{91}Sr	-	$4\text{E}+3$	$1\text{E}+6$	$5\text{E}+9$	-	-
38	Strontium-92	D, see ^{92}Sr	$3\text{E}+3$	$9\text{E}+3$	$4\text{E}+6$	$1\text{E}+8$	$4\text{E}+5$	$4\text{E}+4$
		Y, see ^{92}Sr	-	$7\text{E}+3$	$3\text{E}+6$	$9\text{E}+9$	-	-
39	Yttrium-86 ²	W, all compounds except those given for Y	$2\text{E}+4$	$6\text{E}+4$	$2\text{E}+5$	$8\text{E}+8$	$3\text{E}+4$	$3\text{E}+3$
		Y, oxides and hydroxides	-	$5\text{E}+4$	$2\text{E}+5$	$8\text{E}+8$	-	-
39	Yttrium-86	W, see ^{86}Y	$1\text{E}+3$	$3\text{E}+3$	$1\text{E}+6$	$5\text{E}+9$	$2\text{E}+5$	$2\text{E}+4$
		Y, see ^{86}Y	-	$3\text{E}+3$	$1\text{E}+6$	$5\text{E}+9$	-	-
39	Yttrium-87	W, see ^{87}Y	$2\text{E}+3$	$3\text{E}+3$	$1\text{E}+6$	$5\text{E}+9$	$3\text{E}+5$	$3\text{E}+4$
		Y, see ^{87}Y	-	$3\text{E}+3$	$1\text{E}+6$	$5\text{E}+9$	-	-
39	Yttrium-88	W, see ^{88}Y	$1\text{E}+3$	$3\text{E}+2$	$1\text{E}+7$	$3\text{E}+10$	$1\text{E}+5$	$1\text{E}+4$
		Y, see ^{88}Y	-	$2\text{E}+2$	$1\text{E}+7$	$3\text{E}+10$	-	-
39	Yttrium-90 ²	W, see ^{90}Y	$8\text{E}+3$	$1\text{E}+4$	$5\text{E}+6$	$2\text{E}+8$	$1\text{E}+4$	$1\text{E}+3$
		Y, see ^{90}Y	-	$1\text{E}+4$	$5\text{E}+6$	$2\text{E}+8$	-	-
39	Yttrium-90	W, see ^{90}Y	$4\text{E}+2$ LLI wall	$7\text{E}+2$	$3\text{E}+7$	$9\text{E}+10$	-	-
		Y, see ^{90}Y	$(5\text{E}+2)$ -	-	-	-	$7\text{E}+6$	$7\text{E}+5$
39	Yttrium-91 ²	W, see ^{91}Y	$1\text{E}+5$	$2\text{E}+5$	$1\text{E}+4$	$3\text{E}+7$	$2\text{E}+3$	$2\text{E}+2$
		Y, see ^{91}Y	-	$2\text{E}+5$	$7\text{E}+5$	$2\text{E}+7$	-	-
39	Yttrium-91	W, see ^{91}Y	$5\text{E}+2$ LLI wall	$2\text{E}+2$	$7\text{E}+8$	$2\text{E}+10$	-	-
		Y, see ^{91}Y	$(6\text{E}+2)$ -	-	-	-	$8\text{E}+6$	$8\text{E}+5$
39	Yttrium-92	W, see ^{92}Y	$3\text{E}+3$	$9\text{E}+3$	$4\text{E}+6$	$1\text{E}+8$	$4\text{E}+5$	$4\text{E}+4$
		Y, see ^{92}Y	-	$8\text{E}+3$	$3\text{E}+6$	$1\text{E}+8$	-	-
39	Yttrium-93	W, see ^{93}Y	$1\text{E}+3$	$3\text{E}+3$	$1\text{E}+6$	$4\text{E}+9$	$2\text{E}+5$	$2\text{E}+4$
		Y, see ^{93}Y	-	$2\text{E}+3$	$1\text{E}+6$	$3\text{E}+9$	-	-
39	Yttrium-94 ²	W, see ^{94}Y	$2\text{E}+4$ St. wall	$8\text{E}+4$	$3\text{E}+5$	$1\text{E}+7$	-	-
		Y, see ^{94}Y	$(3\text{E}+4)$ -	-	-	-	$4\text{E}+4$	$4\text{E}+3$
39	Yttrium-95 ²	W, see ^{95}Y	$4\text{E}+4$ St. wall	$2\text{E}+5$	$6\text{E}+5$	$2\text{E}+7$	-	-
		Y, see ^{95}Y	$(5\text{E}+4)$ -	-	-	-	$7\text{E}+4$	$7\text{E}+3$

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Ingestion ALI (μ Ci)	Inhalation		Col. 1 Air (μ Ci/ml)	Col. 2 Water (μ Ci/ml)	Monthly Average Concentration (μ Ci/ml)
				Col. 2 ALL (μ Ci)	Col. 3 DAC (μ Ci/ml)			
80	Zirconium-86	D, all compounds except those given for W and Y	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
		Y, carbide	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-88	D, see ⁸⁶ Zr	4E+3	2E+2	9E-8	3E-10	5E-5	5E-4
		W, see ⁸⁶ Zr	-	5E+2	2E-7	2E-10	-	-
		Y, see ⁸⁶ Zr	-	3E+2	1E-7	4E-10	-	-
40	Zirconium-89	D, see ⁸⁶ Zr	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ⁸⁶ Zr	-	2E+3	1E-6	3E-9	-	-
		Y, see ⁸⁶ Zr	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-91	D, see ⁸⁶ Zr	1E+3	6E+0	3E-9	-	-	-
		W, see ⁸⁶ Zr	-	Bone surf (2E+1)	-	2E-11	4E-5	4E-4
		Y, see ⁸⁶ Zr	-	Bone surf (6E+1)	-	9E-11	-	-
			-	Bone surf (6E+1)	2E-8	-	-	-
			-	Bone surf (7E+1)	-	9E-11	-	-
40	Zirconium-95	D, see ⁸⁶ Zr	1E+3	1E+2	5E-8	-	2E-5	2E-4
		W, see ⁸⁶ Zr	-	Bone surf (3E+2)	-	4E-10	-	-
		Y, see ⁸⁶ Zr	-	4E+2	2E-7	5E-10	-	-
			-	3E+2	1E-7	4E-10	-	-
40	Zirconium-97	D, see ⁸⁶ Zr	6E+2	2E+3	8E-7	3E-9	9E-6	9E-5
		W, see ⁸⁶ Zr	-	1E+3	6E-7	2E-9	-	-
		Y, see ⁸⁶ Zr	-	1E+3	5E-7	2E-9	-	-
41	Niobium-88 ²	W, all compounds except those given for Y	5E+4 St. wall (7E+4)	2E+5	9E-5	3E-7	-	-
		Y, oxides and hydroxides	-	2E+5	9E-5	3E-7	1E-3	1E-2
41	Niobium-89m ² (66 min)	W, see ⁸⁸ Nb	1E+4	4E+4	2E-5	6E-8	1E-4	1E-3
		Y, see ⁸⁸ Nb	-	4E+4	2E-5	5E-8	-	-
41	Niobium-89 (122 min)	W, see ⁸⁸ Nb	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ⁸⁸ Nb	-	2E+4	6E-6	2E-8	-	-
41	Niobium-90	W, see ⁸⁸ Nb	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		Y, see ⁸⁸ Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-93m	W, see ⁸⁸ Nb	9E+3 LLI wall (1E+4)	2E+3	8E-7	3E-9	-	-
		Y, see ⁸⁸ Nb	-	2E+2	7E-8	2E-10	2E-4	2E-3
41	Niobium-94	W, see ⁸⁸ Nb	9E+2	2E+2	9E-8	3E-10	1E-5	1E-4
		Y, see ⁸⁸ Nb	-	7E+1	6E-9	2E-11	-	-
41	Niobium-95m	W, see ⁸⁸ Nb	2E+3 LLI wall (2E+3)	3E+3	1E-6	4E-9	-	-
		Y, see ⁸⁸ Nb	-	2E+3	9E-7	3E-9	3E-5	3E-4

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
41	Niobium-95	W, see ^{95}Nb Y, see ^{95}Nb	$2\text{E}+3$ -	$1\text{E}+3$ $1\text{E}+3$	$5\text{E}+7$ $5\text{E}+7$	$2\text{E}-9$ $2\text{E}-9$	$3\text{E}-5$ -	$3\text{E}-4$ -
41	Niobium-96	W, see ^{96}Nb Y, see ^{96}Nb	$1\text{E}+3$ -	$3\text{E}+3$ $2\text{E}+3$	$1\text{E}-6$ $1\text{E}-6$	$4\text{E}-9$ $3\text{E}-9$	$2\text{E}-5$ -	$2\text{E}-4$ -
41	Niobium-97 ²	W, see ^{97}Nb Y, see ^{97}Nb	$2\text{E}+4$ -	$8\text{E}+4$ $7\text{E}+4$	$3\text{E}-5$ $3\text{E}-5$	$1\text{E}-7$ $1\text{E}-7$	$3\text{E}+4$ -	$3\text{E}+3$ -
41	Niobium-98 ²	W, see ^{98}Nb Y, see ^{98}Nb	$1\text{E}+4$ -	$5\text{E}+4$ $5\text{E}+4$	$2\text{E}-5$ $2\text{E}-5$	$8\text{E}-8$ $7\text{E}-8$	$2\text{E}-4$ -	$2\text{E}-3$ -
42	Molybdenum-90	D, all compounds except those given for Y Y, oxides, hydroxides, and MoS_2	$4\text{E}+3$ $2\text{E}+3$	$7\text{E}+3$ $5\text{E}+3$	$3\text{E}-6$ $2\text{E}-6$	$1\text{E}-8$ $6\text{E}-9$	$3\text{E}-5$ -	$3\text{E}-4$ -
42	Molybdenum-93a	D, see ^{90}Mo Y, see ^{90}Mo	$9\text{E}+3$ $4\text{E}+3$	$2\text{E}+4$ $1\text{E}+4$	$7\text{E}-6$ $6\text{E}-6$	$2\text{E}-8$ $2\text{E}-8$	$6\text{E}-5$ -	$6\text{E}-4$ -
42	Molybdenum-93	D, see ^{90}Mo Y, see ^{90}Mo	$4\text{E}+3$ $2\text{E}+4$	$5\text{E}+3$ $2\text{E}+2$	$2\text{E}-6$ $8\text{E}-8$	$8\text{E}-9$ $2\text{E}+10$	$5\text{E}-5$ -	$5\text{E}-4$ -
42	Molybdenum-99	D, see ^{90}Mo Y, see ^{90}Mo	$2\text{E}+3$ LI wall ($1\text{E}+3$) $1\text{E}+3$	$3\text{E}+3$ - $1\text{E}+3$	$1\text{E}-6$ - $6\text{E}+7$	$4\text{E}-9$ - $2\text{E}-9$	- $2\text{E}-5$ -	- $2\text{E}-4$ -
42	Molybdenum-101 ²	D, see ^{90}Mo Y, see ^{90}Mo	$4\text{E}+4$ SI wall ($5\text{E}+4$) -	$1\text{E}+5$ - $1\text{E}+5$	$6\text{E}-5$ - $6\text{E}-5$	$2\text{E}+7$ - $2\text{E}-7$	- $7\text{E}-4$ -	- $7\text{E}-3$ -
43	Technetium-93a ²	D, all compounds except those given for W W, oxides, hydroxides, halides, and nitrates	$7\text{E}+4$ -	$2\text{E}+5$ $3\text{E}+5$	$6\text{E}-5$ $1\text{E}-4$	$2\text{E}-7$ $4\text{E}-7$	$1\text{E}-3$ -	$1\text{E}-2$ -
43	Technetium-93	D, see $^{93\text{m}}\text{Tc}$ W, see $^{93\text{m}}\text{Tc}$	$3\text{E}+4$ -	$7\text{E}+4$ $1\text{E}+5$	$3\text{E}-5$ $4\text{E}-5$	$1\text{E}-7$ $1\text{E}-7$	$4\text{E}-4$ -	$4\text{E}-3$ -
43	Technetium-94a ²	D, see $^{93\text{m}}\text{Tc}$ W, see $^{93\text{m}}\text{Tc}$	$2\text{E}+4$ -	$4\text{E}+4$ $6\text{E}+4$	$2\text{E}-5$ $2\text{E}-5$	$6\text{E}-8$ $8\text{E}-8$	$3\text{E}-4$ -	$3\text{E}-3$ -
43	Technetium-94	D, see $^{93\text{m}}\text{Tc}$ W, see $^{93\text{m}}\text{Tc}$	$9\text{E}+3$ -	$2\text{E}+4$ $2\text{E}+4$	$8\text{E}-6$ $1\text{E}-5$	$3\text{E}-8$ $3\text{E}-8$	$1\text{E}-4$ -	$1\text{E}-3$ -
43	Technetium-95a	D, see $^{93\text{m}}\text{Tc}$ W, see $^{93\text{m}}\text{Tc}$	$4\text{E}+3$ -	$5\text{E}+3$ $2\text{E}+3$	$2\text{E}-6$ $8\text{E}-7$	$8\text{E}-9$ $3\text{E}-9$	$5\text{E}-5$ -	$5\text{E}-4$ -
43	Technetium-95	D, see $^{93\text{m}}\text{Tc}$ W, see $^{93\text{m}}\text{Tc}$	$1\text{E}+4$ -	$2\text{E}+4$ $2\text{E}+4$	$9\text{E}-6$ $8\text{E}-6$	$3\text{E}-8$ $3\text{E}-8$	$1\text{E}-4$ -	$1\text{E}-3$ -
43	Technetium-96a ²	D, see $^{93\text{m}}\text{Tc}$ W, see $^{93\text{m}}\text{Tc}$	$2\text{E}+5$ -	$3\text{E}+5$ $2\text{E}+5$	$1\text{E}-4$ $1\text{E}-4$	$4\text{E}-7$ $3\text{E}+7$	$2\text{E}-3$ -	$2\text{E}-2$ -
43	Technetium-96	D, see $^{93\text{m}}\text{Tc}$ W, see $^{93\text{m}}\text{Tc}$	$2\text{E}+3$ -	$3\text{E}+3$ $2\text{E}+3$	$1\text{E}-6$ $9\text{E}-7$	$5\text{E}-9$ $3\text{E}-9$	$3\text{E}-5$ -	$3\text{E}-4$ -
43	Technetium-97a	D, see $^{93\text{m}}\text{Tc}$ W, see $^{93\text{m}}\text{Tc}$	$5\text{E}+3$ - ($7\text{E}+3$) $1\text{E}+3$	$7\text{E}+3$ SI wall $1\text{E}+3$	$3\text{E}-6$ - $5\text{E}-7$	- $1\text{E}-8$ $2\text{E}-9$	$6\text{E}-5$ -	$6\text{E}-4$ -

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Atomic No	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion AI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{m}^3$)	Col. 2 Water ($\mu\text{Ci}/\text{m}^3$)	Monthly Average Concentration ($\mu\text{Ci}/\text{m}^3$)
				AI (μCi)	DAC ($\mu\text{Ci}/\text{m}^3$)			
43	Technetium-97	D, see $^{99\text{m}}\text{Tc}$ W, see $^{99\text{m}}\text{Tc}$	4E+4 -	5E+4 5E+3	2E-5 2E-6	7E-8 8E-9	5E-4 -	5E-3 -
43	Technetium-98	D, see $^{99\text{m}}\text{Tc}$ W, see $^{99\text{m}}\text{Tc}$	1E+3 -	2E+3 3E+2	7E-7 1E-7	2E-9 4E-10	1E-5 -	1E-4 -
43	Technetium-99m	D, see $^{99\text{m}}\text{Tc}$ W, see $^{99\text{m}}\text{Tc}$	8E+4 -	2E+5 2E+5	6E-5 1E-4	2E-7 3E-7	1E-3 -	1E-2 -
43	Technetium-99	D, see $^{99\text{m}}\text{Tc}$ W, see $^{99\text{m}}\text{Tc}$	4E+3 -	5E+3 St. wall (6E+3) 7E+2	2E-6 -	- 8E-9 9E-10	6E-5 -	6E-4 -
43	Technetium-101 ²	D, see $^{99\text{m}}\text{Tc}$ W, see $^{99\text{m}}\text{Tc}$	9E+4 (1E+5) -	3E+5 -	1E-4 -	5E-7 -	- 2E-3 -	- 2E-2 -
43	Technetium-104 ²	D, see $^{99\text{m}}\text{Tc}$ W, see $^{99\text{m}}\text{Tc}$	2E+4 (3E+4) -	7E+4 -	3E-5 -	1E-7 -	- 4E-4 -	- 4E-3 -
44	Ruthenium-94 ²	D, all compounds except those given for W and Y W, halides Y, oxides and hydroxides	2E+4 - -	4E+4 6E+4 6E+4	2E-5 3E-5 2E-5	6E-8 9E-8 8E-8	2E-4 -	2E-3 -
44	Ruthenium-97	D, see ^{94}Ru W, see ^{94}Ru Y, see ^{94}Ru	8E+3 - -	2E+4 1E+4 1E+4	8E-6 5E-6 5E-6	3E-8 2E-8 2E-8	1E-4 -	1E-3 -
44	Ruthenium-103	D, see ^{94}Ru W, see ^{94}Ru Y, see ^{94}Ru	2E+3 - -	2E+3 1E+3 6E+2	7E-7 4E-7 3E-7	2E-9 1E-9 9E-10	3E-5 -	3E-4 -
44	Ruthenium-105	D, see ^{94}Ru W, see ^{94}Ru Y, see ^{94}Ru	5E+3 - -	1E+4 1E+4 1E+4	6E-6 6E-6 5E-6	2E-8 2E-8 2E-8	7E-5 -	7E-4 -
44	Ruthenium-106	D, see ^{94}Ru W, see ^{94}Ru Y, see ^{94}Ru	2E+2 (2E+2) -	9E+1 -	4E-8 -	1E-10 -	- 3E-6 -	- 3E-5 -
45	Rhodium-99m	D, all compounds except those given for W and Y W, halides Y, oxides and hydroxides	2E+4 - -	6E+4 8E+4 7E+4	2E-5 3E-5 3E-5	8E-8 1E-7 9E-8	2E-4 -	2E-3 -
45	Rhodium-99	D, see $^{99\text{m}}\text{Rh}$ W, see $^{99\text{m}}\text{Rh}$ Y, see $^{99\text{m}}\text{Rh}$	2E+3 - -	3E+3 2E+3 2E+3	1E-6 9E-7 8E-7	4E-9 3E-9 3E-9	3E-5 -	3E-4 -

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
			Oral Ingestion All (μCi)	Inhalation All (μCi)	INAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
45	Rhodium-100	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	2E+3	5E+3	2E+6	7E-9	2E-5	2E-4
			-	4E+3	2E+6	6E-9	-	-
			-	4E+3	2E+6	5E-9	-	-
45	Rhodium-101a	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	6E+3	1E+4	5E+6	2E-8	8E-5	8E-4
			-	8E+3	4E+6	1E-8	-	-
			-	8E+3	3E+6	1E-8	-	-
45	Rhodium-101	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	2E+3	5E+2	2E+7	7E-10	3E-5	3E-4
			-	8E+2	3E+7	1E-9	-	-
			-	2E+2	6E+8	2E-10	-	-
45	Rhodium-102a	D, see ^{99m} Rh	1E+3	5E+2	2E+7	7E-10	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		W, see ^{99m} Rh	-	4E+2	2E+7	5E-10	-	-
		Y, see ^{99m} Rh	-	1E+2	5E+8	2E-10	-	-
45	Rhodium-102	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	6E+2	9E+1	4E+8	1E-10	8E-6	8E-5
			-	2E+2	7E+8	2E-10	-	-
			-	6E+1	2E+8	8E-11	-	-
45	Rhodium-103a ²	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	4E+5	1E+6	5E+4	2E-6	6E-3	6E-2
			-	1E+6	5E+4	2E-6	-	-
			-	1E+6	5E+4	2E-6	-	-
45	Rhodium-105	D, see ^{99m} Rh	4E+3	1E+4	5E+6	2E-8	-	-
			LLI wall (4E+3)	-	-	-	5E-5	5E-4
		W, see ^{99m} Rh	-	6E+3	3E+6	9E-9	-	-
		Y, see ^{99m} Rh	-	6E+3	2E+6	8E-9	-	-
45	Rhodium-106a	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	8E+3	3E+4	1E+5	4E-8	1E-4	1E-3
			-	4E+4	2E+5	5E-8	-	-
			-	4E+4	1E+5	5E-8	-	-
45	Rhodium-107 ²	D, see ^{99m} Rh	7E+4	2E+5	1E+4	3E+7	-	-
			SLI wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{99m} Rh	-	3E+5	1E+4	4E+7	-	-
		Y, see ^{99m} Rh	-	3E+5	1E+4	3E+7	-	-
46	Palladium-100	D, all compounds except those given for W and Y W, nitrates Y, oxides and hydroxides	1E+3	1E+3	6E+7	2E-9	2E-5	2E-4
			-	1E+3	5E+7	2E-9	-	-
			-	1E+3	6E+7	2E-9	-	-
46	Palladium-101	D, see ¹⁰⁰ Pd W, see ¹⁰⁰ Pd Y, see ¹⁰⁰ Pd	1E+4	3E+4	1E+5	5E-6	2E-4	2E-3
			-	3E+4	1E+5	5E-6	-	-
			-	3E+4	1E+5	4E-6	-	-
46	Palladium-103	D, see ¹⁰⁰ Pd	6E+3	6E+3	3E+6	9E-9	-	-
			LLI wall (7E+3)	-	-	-	1E-4	1E-3
		W, see ¹⁰⁰ Pd	-	4E+3	2E+6	6E-9	-	-
		Y, see ¹⁰⁰ Pd	-	4E+3	1E+6	5E-9	-	-
46	Palladium-107	D, see ¹⁰⁰ Pd	3E+4	2E+4	9E+6	-	-	-
			LLI wall (4E+4)	Kidneys (2E+4)	-	-	5E-4	5E-3
		W, see ¹⁰⁰ Pd	-	7E+3	3E+6	1E-8	-	-
		Y, see ¹⁰⁰ Pd	-	4E+2	2E+7	6E-10	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				ALI (μCi)	DAC ($\mu\text{Ci}/\text{ml}$)			
46	Palladium-109	D, see ^{109}Pd W, see ^{109}Pd Y, see ^{109}Pd	$2\text{E}+3$ " "	$6\text{E}+3$ $5\text{E}+3$ $5\text{E}+3$	$3\text{E}-6$ $2\text{E}-6$ $2\text{E}-6$	$9\text{E}-9$ $8\text{E}-9$ $6\text{E}-9$	$3\text{E}-5$ " "	$3\text{E}-4$ " "
47	Silver- 102	D, all compounds except those given for W and Y	$5\text{E}+4$ St. wall ($6\text{E}+4$)	$2\text{E}+5$ " "	$6\text{E}-5$ " "	$2\text{E}-7$ " "	" $9\text{E}-4$ "	" $9\text{E}-3$ "
		W, nitrates and sulfides	"	$2\text{E}+5$	$9\text{E}-5$	$3\text{E}-7$	"	"
		Y, oxides and hydroxides	"	$2\text{E}+5$	$6\text{E}-5$	$3\text{E}-7$	"	"
47	Silver- 103	D, see ^{103}Ag W, see ^{103}Ag Y, see ^{103}Ag	$4\text{E}+4$ " "	$1\text{E}+5$ $1\text{E}+5$ $1\text{E}+5$	$4\text{E}-5$ $5\text{E}-5$ $5\text{E}-5$	$1\text{E}-7$ $2\text{E}-7$ $2\text{E}-7$	$5\text{E}-4$ " "	$5\text{E}-3$ " "
47	Silver- 104	D, see ^{104}Ag W, see ^{104}Ag Y, see ^{104}Ag	$3\text{E}+4$ " "	$9\text{E}+4$ $1\text{E}+5$ $1\text{E}+5$	$4\text{E}-5$ $5\text{E}-5$ $5\text{E}-5$	$1\text{E}-7$ $2\text{E}-7$ $2\text{E}-7$	$4\text{E}-4$ " "	$4\text{E}-3$ " "
47	Silver- 106	D, see ^{106}Ag W, see ^{106}Ag Y, see ^{106}Ag	$2\text{E}+4$ " "	$7\text{E}+4$ $1\text{E}+5$ $1\text{E}+5$	$3\text{E}-5$ $6\text{E}-5$ $6\text{E}-5$	$1\text{E}-7$ $2\text{E}-7$ $2\text{E}-7$	$3\text{E}-4$ " "	$3\text{E}-3$ " "
47	Silver-105	D, see ^{105}Ag W, see ^{105}Ag Y, see ^{105}Ag	$3\text{E}+3$ " "	$1\text{E}+3$ $2\text{E}+2$ $2\text{E}+2$	$4\text{E}-7$ $7\text{E}-7$ $7\text{E}-7$	$1\text{E}-9$ $2\text{E}-9$ $2\text{E}-9$	$4\text{E}-5$ " "	$4\text{E}-4$ " "
47	Silver-106m	D, see $^{106\text{m}}\text{Ag}$ W, see $^{106\text{m}}\text{Ag}$ Y, see $^{106\text{m}}\text{Ag}$	$8\text{E}+2$ " "	$7\text{E}+2$ $9\text{E}+2$ $9\text{E}+2$	$3\text{E}-7$ $4\text{E}-7$ $4\text{E}-7$	$1\text{E}-9$ $1\text{E}-9$ $1\text{E}-9$	$1\text{E}-5$ " "	$1\text{E}-4$ " "
47	Silver- 106	D, see ^{106}Ag	$6\text{E}+1$ St. wall ($6\text{E}+4$)	$2\text{E}+5$ " "	$6\text{E}-5$ " "	$3\text{E}-7$ " "	" $5\text{E}-4$ "	" $9\text{E}-3$ "
		W, see ^{106}Ag Y, see ^{106}Ag	" "	$2\text{E}+5$ $2\text{E}+5$	$9\text{E}-5$ $8\text{E}-5$	$3\text{E}-7$ $3\text{E}-7$	" "	" "
47	Silver-108m	D, see $^{108\text{m}}\text{Ag}$ W, see $^{108\text{m}}\text{Ag}$ Y, see $^{108\text{m}}\text{Ag}$	$6\text{E}+2$ " "	$2\text{E}+2$ $3\text{E}+1$ $2\text{E}+1$	$8\text{E}-8$ $1\text{E}-7$ $1\text{E}-8$	$3\text{E}-10$ $4\text{E}-10$ $3\text{E}-11$	$9\text{E}-6$ " "	$9\text{E}-5$ " "
47	Silver-110m	D, see $^{110\text{m}}\text{Ag}$ W, see $^{110\text{m}}\text{Ag}$ Y, see $^{110\text{m}}\text{Ag}$	$5\text{E}+2$ " "	$1\text{E}+2$ $2\text{E}+2$ $9\text{E}+1$	$5\text{E}-8$ $8\text{E}-8$ $4\text{E}-8$	$2\text{E}-10$ $3\text{E}-10$ $1\text{E}-10$	$6\text{E}-6$ " "	$6\text{E}-5$ " "
47	Silver-111	D, see ^{111}Ag	$9\text{E}+2$ St. wall ($1\text{E}+3$)	$2\text{E}+3$ ($2\text{E}+3$)	$6\text{E}-7$ "	" $2\text{E}-9$	" $2\text{E}-5$	" $2\text{E}-4$
		W, see ^{111}Ag Y, see ^{111}Ag	" "	$9\text{E}+2$ $9\text{E}+2$	$4\text{E}-7$ $4\text{E}-7$	$1\text{E}-9$ $1\text{E}-9$	" "	" "
47	Silver-112	D, see ^{112}Ag W, see ^{112}Ag Y, see ^{112}Ag	$3\text{E}+3$ " "	$8\text{E}+3$ $1\text{E}+4$ $9\text{E}+3$	$3\text{E}-6$ $4\text{E}-6$ $4\text{E}-6$	$1\text{E}-8$ $1\text{E}-8$ $1\text{E}-8$	$4\text{E}-5$ " "	$4\text{E}-4$ " "

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				All	DAC			
47	Silver-115 ²	D, see ¹⁰² Ag	3E+4 St. wall (3E+4)	9E+4	4E-5	1E-7	-	-
		W, see ¹⁰² Ag	-	9E+4	4E-5	1E-7	4E-4	4E-3
		Y, see ¹⁰² Ag	-	8E+4	3E-5	1E-7	-	-
48	Cadmium-104 ²	D, all compounds except those given for W and Y	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-
48	Cadmium-107	D, see ¹⁰⁴ Cd	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
		W, see ¹⁰⁴ Cd	-	6E+4	2E-5	8E-8	-	-
		Y, see ¹⁰⁴ Cd	-	5E+4	2E-5	7E-8	-	-
48	Cadmium-109	D, see ¹⁰⁴ Cd	3E+2 Kidneys (4E+2)	4E+1 Kidneys (5E+1) 1E+2 Kidneys (1E+2)	1E-8 - 5E-8 -	- 7E-11 -	- 6E-6 -	- 6E-5 -
		W, see ¹⁰⁴ Cd	-	1E+2	5E-8	2E-10	-	-
		Y, see ¹⁰⁴ Cd	-	1E+2	5E-8	2E-10	-	-
48	Cadmium-113m	D, see ¹⁰⁴ Cd	2E+1 Kidneys (4E+1)	2E+0 Kidneys (4E+0) 8E+0 Kidneys (1E+1)	1E-9 - 4E-9 -	- 5E-12 -	- 5E-7 -	- 5E-6 -
		W, see ¹⁰⁴ Cd	-	1E+1	5E-9	2E-11	-	-
		Y, see ¹⁰⁴ Cd	-	1E+1	5E-9	2E-11	-	-
48	Cadmium-113	D, see ¹⁰⁴ Cd	2E+1 Kidneys (3E+1)	2E+0 Kidneys (3E+0) 8E+0 Kidneys (1E+1)	9E-10 - 3E-9 -	- 5E-12 -	- 4E-7 -	- 4E-6 -
		W, see ¹⁰⁴ Cd	-	1E+1	6E-9	2E-11	-	-
		Y, see ¹⁰⁴ Cd	-	1E+1	6E-9	2E-11	-	-
48	Cadmium-115a	D, see ¹⁰⁴ Cd	3E+2	5E+1 Kidneys (8E+1)	2E-8 - 1E-8	- 1E-10 2E-10	4E-6 -	4E-5 -
		W, see ¹⁰⁴ Cd	-	1E+2	5E-8	2E-10	-	-
		Y, see ¹⁰⁴ Cd	-	1E+2	6E-8	2E-10	-	-
48	Cadmium-115	D, see ¹⁰⁴ Cd	9E+2 LLI wall (1E+3)	1E+3	6E-7	2E-9	-	-
		W, see ¹⁰⁴ Cd	-	1E+3	5E-7	2E-9	1E-5	1E-4
		Y, see ¹⁰⁴ Cd	-	1E+3	6E-7	2E-9	-	-
48	Cadmium-117a	D, see ¹⁰⁴ Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		W, see ¹⁰⁴ Cd	-	2E+4	7E-6	2E-8	-	-
		Y, see ¹⁰⁴ Cd	-	1E+4	6E-6	2E-8	-	-

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)	Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
48	Cadmium-117	D, see ^{104}Cd W, see ^{104}Cd Y, see ^{104}Cd	5E+3 - -	1E+4 2E+4 1E+4	5E-6 7E-6 6E-6	2E-8 2E-8 2E-8	6E-5 -	6E-4 -
49	Indium-109	D, all compounds except those given for W W, oxides, hydroxides, halides, and nitrates	2E+4 -	4E+4 6E+4	2E-5 3E-5	6E-8 9E-8	3E-4 -	3E-3 -
49	Indium-110 ² (69.1 min)	D, see ^{109}In W, see ^{109}In	2E+4 -	4E+4 6E+4	2E-5 2E-5	6E-8 8E-8	2E-4 -	2E-3 -
49	Indium-110 (4.9 h)	D, see ^{109}In W, see ^{109}In	5E+3 -	2E+4 2E+4	7E-6 8E-6	2E-8 3E-8	7E-5 -	7E-4 -
49	Indium-111	D, see ^{109}In W, see ^{109}In	4E+3 -	6E+3 6E+3	3E-6 3E-6	9E-9 9E-9	6E-5 -	6E-4 -
49	Indium-112 ²	D, see ^{109}In W, see ^{109}In	2E+5 -	6E+5 7E+5	3E-4 3E-4	9E-7 1E-6	2E-3 -	2E-2 -
49	Indium-113a ²	D, see ^{109}In W, see ^{109}In	5E+4 -	1E+5 2E+5	6E-5 8E-5	2E-7 3E-7	7E-4 -	7E-3 -
49	Indium-114a	D, see ^{109}In W, see ^{109}In	3E+2 LLI wall (4E+2)	6E+1 -	3E-8 -	9E-11 -	- 5E-6	- 5E-5
49	Indium-115a	D, see ^{109}In W, see ^{109}In	1E+4 -	4E+4 5E+4	2E-5 2E-5	6E-8 7E-8	2E-4 -	2E-3 -
49	Indium-115	D, see ^{109}In W, see ^{109}In	4E+1 -	1E+0 5E+0	6E-10 2E-9	2E-12 8E-12	5E-7 -	5E-6 -
49	Indium-116a ²	D, see ^{109}In W, see ^{109}In	2E+4 -	8E+4 1E+5	3E-5 5E-5	1E-7 2E-7	3E-4 -	3E-3 -
49	Indium-117a ²	D, see ^{109}In W, see ^{109}In	1E+4 -	3E+4 4E+4	1E-5 2E-5	5E-8 6E-8	2E-4 -	2E-3 -
49	Indium-117 ²	D, see ^{109}In W, see ^{109}In	6E+4 -	2E+5 2E+5	7E-5 9E-5	2E-7 3E-7	8E-4 -	8E-3 -
49	Indium-119a ²	D, see ^{109}In W, see ^{109}In	4E+4 SL wall (5E+4)	1E+5 -	5E-5 -	2E-7 -	- 7E-4	- 7E-3
50	Tin-110	D, all compounds except those given for W W, sulfides, oxides, hydroxides, halides, nitrates, and stannic phosphate	4E+3 -	1E+4 1E+4	5E-6 5E-6	2E-8 2E-8	5E-5 -	5E-4 -
50	Tin-111 ²	D, see ^{110}Sn W, see ^{110}Sn	7E+4 -	2E+5 3E+5	9E-5 1E-4	3E-7 4E-7	1E-3 -	1E-2 -

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
50	Tin-113	D, see ^{110}Sn	$2\text{E}+3$ LLI wall ($2\text{E}+3$)	$3\text{E}+3$	$5\text{E}-7$	$2\text{E}-9$	-	-
		W, see ^{110}Sn	-	$5\text{E}+2$	$2\text{E}-7$	$8\text{E}-10$	$3\text{E}-5$	$3\text{E}-4$
50	Tin-117m	D, see ^{110}Sn	$2\text{E}+3$ LLI wall ($2\text{E}+3$)	$1\text{E}+3$ Bone surf ($2\text{E}+3$)	$5\text{E}-7$	-	-	-
		W, see ^{110}Sn	-	$1\text{E}+3$	$6\text{E}-7$	$3\text{E}-9$	$3\text{E}-5$	$3\text{E}-4$
50	Tin-119m	D, see ^{110}Sn	$3\text{E}+3$ LLI wall ($4\text{E}+3$)	$2\text{E}+3$	$1\text{E}-6$	$3\text{E}-9$	-	-
		W, see ^{110}Sn	-	$1\text{E}+3$	$4\text{E}-7$	$1\text{E}-9$	$6\text{E}-5$	$6\text{E}-4$
50	Tin-121m	D, see ^{110}Sn	$3\text{E}+3$ LLI wall ($4\text{E}+3$)	$9\text{E}+2$	$4\text{E}-7$	$1\text{E}-9$	-	-
		W, see ^{110}Sn	-	$5\text{E}+2$	$2\text{E}-7$	$8\text{E}-10$	$5\text{E}-5$	$5\text{E}-4$
50	Tin-121	D, see ^{110}Sn	$6\text{E}+3$ LLI wall ($6\text{E}+3$)	$2\text{E}+4$	$6\text{E}-6$	$2\text{E}-8$	-	-
		W, see ^{110}Sn	-	$1\text{E}+4$	$5\text{E}-6$	$2\text{E}-8$	$8\text{E}-5$	$8\text{E}-4$
50	Tin-123m ²	D, see ^{110}Sn	$5\text{E}+4$	$1\text{E}+5$	$5\text{E}-5$	$2\text{E}-7$	$7\text{E}-4$	$7\text{E}-3$
		W, see ^{110}Sn	-	$1\text{E}+5$	$6\text{E}-5$	$2\text{E}-7$	-	-
50	Tin-123	D, see ^{110}Sn	$5\text{E}+2$ LLI wall ($6\text{E}+2$)	$6\text{E}+2$	$3\text{E}-7$	$9\text{E}-10$	-	-
		W, see ^{110}Sn	-	$2\text{E}+2$	$7\text{E}-8$	$2\text{E}-10$	$9\text{E}-6$	$9\text{E}-5$
50	Tin-125	D, see ^{110}Sn	$4\text{E}+2$ LLI wall ($5\text{E}+2$)	$9\text{E}+2$	$4\text{E}-7$	$1\text{E}-9$	-	-
		W, see ^{110}Sn	-	$4\text{E}+2$	$1\text{E}-7$	$5\text{E}-10$	$6\text{E}-6$	$6\text{E}-5$
50	Tin-126	D, see ^{110}Sn	$3\text{E}+2$	$6\text{E}+1$	$2\text{E}-8$	$8\text{E}-11$	$4\text{E}-6$	$4\text{E}-5$
		W, see ^{110}Sn	-	$7\text{E}+1$	$3\text{E}-8$	$9\text{E}-11$	-	-
50	Tin-127	D, see ^{110}Sn	$7\text{E}+3$	$2\text{E}+4$	$8\text{E}-6$	$3\text{E}-8$	$9\text{E}-5$	$9\text{E}-4$
		W, see ^{110}Sn	-	$2\text{E}+4$	$8\text{E}-6$	$3\text{E}-8$	-	-
50	Tin-128 ²	D, see ^{110}Sn	$9\text{E}+3$	$3\text{E}+4$	$1\text{E}-5$	$4\text{E}-8$	$1\text{E}-4$	$1\text{E}-3$
		W, see ^{110}Sn	-	$4\text{E}+4$	$1\text{E}-5$	$5\text{E}-8$	-	-
51	Antimony-115 ²	D, all compounds except those given for W	$8\text{E}+4$	$2\text{E}+5$	$1\text{E}-4$	$3\text{E}-7$	$1\text{E}-3$	$1\text{E}-2$
		W, oxides, hydroxides, halides, sulfides, sulfates, and nitrates	-	$3\text{E}+5$	$1\text{E}-4$	$4\text{E}-7$	-	-
51	Antimony-116m ²	D, see ^{115}Sb	$2\text{E}+4$	$7\text{E}+4$	$3\text{E}-5$	$1\text{E}-7$	$3\text{E}-4$	$3\text{E}-3$
		W, see ^{115}Sb	-	$1\text{E}+5$	$6\text{E}-5$	$2\text{E}-7$	-	-
51	Antimony-116 ²	D, see ^{115}Sb	$7\text{E}+4$ St. wall ($9\text{E}+4$)	$3\text{E}+5$	$1\text{E}-4$	$4\text{E}-7$	-	-
		W, see ^{115}Sb	-	$3\text{E}+5$	$1\text{E}-4$	$5\text{E}-7$	$1\text{E}-3$	$1\text{E}-2$
51	Antimony-117	D, see ^{115}Sb	$7\text{E}+4$	$2\text{E}+5$	$9\text{E}-5$	$3\text{E}-7$	$9\text{E}-4$	$9\text{E}-3$
		W, see ^{115}Sb	-	$3\text{E}+5$	$1\text{E}-4$	$4\text{E}-7$	-	-

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion All (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 All (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
51	Antimony-118m	D, see 115Sb W, see 115Sb	6E+3 5E+3	2E+4 2E+4	8E-6 9E-6	3E-8 3E-8	7E-5 -	7E-4 -
51	Antimony-119	D, see 115Sb W, see 115Sb	2E+4 2E+4	5E+4 3E+4	2E-5 1E-5	6E-8 4E-8	2E-4 -	2E-3 -
51	Antimony-120 ² (16 min)	D, see 115Sb W, see 115Sb	1E+5 (2E+5) St. wall	4E+5 -	2E-4 -	6E-7 -	- 2E-3	- 2E-2
51	Antimony-120 (5.76 d)	D, see 115Sb W, see 115Sb	1E+3 9E+2	2E+3 1E+3	9E-7 5E-7	3E-9 2E-9	1E-5 -	1E-4 -
51	Antimony-122	D, see 115Sb W, see 115Sb	8E+2 (8E+2) L.L. wall	2E+3 -	1E-6 -	3E-9 -	- 1E-5	- 1E-4
51	Antimony-124m ²	D, see 115Sb W, see 115Sb	3E+5 2E+5	8E+5 6E+5	4E-4 2E-4	1E-6 8E-7	3E-3 -	3E-2 -
51	Antimony-124	D, see 115Sb W, see 115Sb	6E+2 5E+2	9E+2 2E+2	4E-7 1E-7	1E-9 3E-10	7E-6 -	7E-5 -
51	Antimony-125	D, see 115Sb W, see 115Sb	2E+3 -	2E+3 5E+2	1E-6 2E-7	3E-9 7E-10	3E-5 -	3E-4 -
51	Antimony-126m ²	D, see 115Sb W, see 115Sb	5E+4 (7E+4) St. wall	2E+5 -	8E-5 -	3E-7 -	- 9E-4	- 9E-3
51	Antimony-126	D, see 115Sb W, see 115Sb	6E+2 5E+2	1E+3 5E+2	5E-7 2E-7	2E-9 7E-10	7E-6 -	7E-5 -
51	Antimony-127	D, see 115Sb W, see 115Sb	8E+2 (8E+2) L.L. wall	2E+3 -	9E-7 -	3E-9 -	- 1E-5	- 1E-4
51	Antimony-128 ² (10.4 min)	D, see 115Sb W, see 115Sb	8E+4 (1E+5) St. wall	4E+5 -	2E-4 -	5E-7 -	- 1E-3	- 1E-2
51	Antimony-128 (9.01 h)	D, see 115Sb W, see 115Sb	1E+3 -	4E+3 3E+3	2E-6 1E-6	6E-9 5E-9	2E-5 -	2E-4 -
51	Antimony-129	D, see 115Sb W, see 115Sb	3E+3 -	9E+3 9E+3	4E-6 4E-6	1E-8 1E-8	4E-5 -	4E-4 -
51	Antimony-130 ²	D, see 115Sb W, see 115Sb	2E+4 -	6E+4 8E+4	3E-5 3E-5	9E-8 1E-7	3E-4 -	3E-3 -
51	Antimony-131 ²	D, see 115Sb W, see 115Sb	1E+4 (2E+4) Thyroid	2E+4 (4E+4) Thyroid	1E-5 -	- 6E-8	- 2E-4	- 2E-3

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion AI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 AI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
52	Tellurium-116	D, all compounds except those given for W	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, oxides, hydroxides, and nitrates	-	3E+4	1E-5	4E-8	-	-
52	Tellurium-121m	D, see ^{116}Te	5E+2 Bone surf (7E+2)	2E+2 Bone surf (4E+2)	8E-6	-	-	-
		W, see ^{116}Te	-	4E+2	2E-7	5E-10 6E-10	1E-5	1E-4
52	Tellurium-121	D, see ^{116}Te	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{116}Te	-	3E+3	1E-6	4E-9	-	-
52	Tellurium-123m	D, see ^{116}Te	6E+2 Bone surf (1E+3)	2E+2 Bone surf (5E+2)	9E-6	-	-	-
		W, see ^{116}Te	-	5E+2	2E-7	8E-10 8E-10	1E-5	1E-4
52	Tellurium-123	D, see ^{116}Te	5E+2 Bone surf (1E+3)	2E+2 Bone surf (5E+2)	8E-6	-	-	-
		W, see ^{116}Te	-	4E+2 Bone surf (1E+3)	2E-7	7E-10 2E-9	2E-5	2E-4
52	Tellurium-125m	D, see ^{116}Te	1E+3 Bone surf (1E+3)	4E+2 Bone surf (1E+3)	2E-7	-	-	-
		W, see ^{116}Te	-	7E+2	3E-7	1E-9 1E-9	2E-5	2E-4
52	Tellurium-127m	D, see ^{116}Te	6E+2	3E+2 Bone surf (4E+2)	1E-7	-	9E-6	9E-5
		W, see ^{116}Te	-	3E+2	1E-7	6E-10 4E-10	-	-
52	Tellurium-127	D, see ^{116}Te	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{116}Te	-	2E+4	7E-6	2E-8	-	-
52	Tellurium-129m	D, see ^{116}Te	5E+2	6E+2	3E-7	9E-10	7E-6	7E-5
		W, see ^{116}Te	-	2E+2	1E-7	3E-10	-	-
52	Tellurium-129 ²	D, see ^{116}Te	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{116}Te	-	7E+4	3E-5	1E-7	-	-
52	Tellurium-131m	D, see ^{116}Te	3E+2 Thyroid (6E+2)	4E+2 Thyroid (1E+3)	2E-7	-	-	-
		W, see ^{116}Te	-	4E+2 Thyroid (9E+2)	2E-7	2E-9 1E-9	8E-6	8E-5
52	Tellurium-131 ²	D, see ^{116}Te	3E+3 Thyroid (6E+3)	5E+3 Thyroid (1E+4)	2E-6	-	-	-
		W, see ^{116}Te	-	5E+3 Thyroid (1E+4)	2E-6	2E-8	8E-5	8E-4
			-	-	-	2E-8	-	-

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Atomic No	Radionuclide	Class	Table 1 Occupational values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
			Oral Ingestion AI (μCi)	Inhalation		Air ($\mu\text{Ci}/\text{ml}$)	Water ($\mu\text{Ci}/\text{ml}$)	
				AI (μCi)	DAE ($\mu\text{Ci}/\text{ml}$)			
52	Tellurium-132	D, see ^{116}Te	2E+2 Thyroid (7E+2)	2E+2 Thyroid (8E+2)	9E-8	-	-	-
		W, see ^{116}Te	-	2E+2 Thyroid (6E+2)	9E-8	1E-9	9E-6	9E-5
52	Tellurium-133m ²	D, see ^{116}Te	3E+3 Thyroid (6E+3)	5E+3 Thyroid (1E+4)	2E-6	-	-	-
		W, see ^{116}Te	-	5E+3 Thyroid (1E+4)	2E-6	2E-8	9E-5	9E-4
52	Tellurium-133 ²	D, see ^{116}Te	1E+4 Thyroid (3E+4)	2E+4 Thyroid (6E+4)	9E-6	-	-	-
		W, see ^{116}Te	-	2E+4 Thyroid (4E+4)	9E-6	8E-8	4E-4	4E-3
52	Tellurium-134 ²	D, see ^{116}Te	2E+4 Thyroid (2E+4)	2E+4 Thyroid (5E+4)	1E-5	-	-	-
		W, see ^{116}Te	-	2E+4 Thyroid (5E+4)	1E-5	7E-8	1E-4	3E-3
53	Iodine-120m ²	D, all compounds	1E+4 Thyroid (1E+4)	2E+4	9E-6	3E-8	-	-
53	Iodine-120 ²	D, all compounds	4E+3 Thyroid (8E+3)	9E+3 Thyroid (1E+4)	4E-6	-	2E-4	2E-3
53	Iodine-121	D, all compounds	1E+4 Thyroid (3E+4)	2E+4 Thyroid (5E+4)	8E-6	-	-	-
53	Iodine-123	D, all compounds	3E+3 Thyroid (1E+4)	6E+3 Thyroid (2E+4)	2E-6	7E-8	4E-4	4E-3
53	Iodine-124	D, all compounds	5E+1 Thyroid (2E+2)	8E+1 Thyroid (3E+2)	3E-8	-	-	-
53	Iodine-125	D, all compounds	4E+1 Thyroid (1E+2)	6E+1 Thyroid (2E+2)	3E-8	-	-	-
53	Iodine-126	D, all compounds	2E+1 Thyroid (7E+1)	4E+1 Thyroid (1E+2)	1E-8	-	-	-
53	Iodine-128 ²	D, all compounds	4E+4 St. wall (6E+4)	1E+5	5E-5	2E-7	-	-
53	Iodine-129	D, all compounds	5E+0 Thyroid (2E+1)	9E+0 Thyroid (3E+1)	4E-9	-	8E-4	8E-3
						4E-11	2E-7	2E-6

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{m}^3$)	Col. 2 Water ($\mu\text{Ci}/\text{m}^3$)	Monthly Average Concentration ($\mu\text{Ci}/\text{m}^3$)
				All (μCi)	DAC ($\mu\text{Ci}/\text{m}^3$)			
53	Iodine-130	D, all compounds	4E+2 Thyroid (1E+3)	7E+2 Thyroid (2E+3)	3E-7	-	-	-
53	Iodine-131	D, all compounds	3E+1 Thyroid (9E+1)	5E+1 Thyroid (2E+2)	2E-8	-	-	-
53	Iodine-132 ²	D, all compounds	4E+3 Thyroid (1E+4)	8E+3 Thyroid (2E+4)	4E-6	-	-	-
53	Iodine-132	D, all compounds	4E+3 Thyroid (9E+3)	8E+3 Thyroid (1E+4)	3E-6	-	-	-
53	Iodine-133	D, all compounds	1E+2 Thyroid (5E+2)	3E+2 Thyroid (9E+2)	1E-7	-	-	-
53	Iodine-134 ²	D, all compounds	7E+4 Thyroid (3E+4)	5E+4	2E-5	6E-8	-	-
53	Iodine-135	D, all compounds	8E+2 Thyroid (3E+3)	2E+3 Thyroid (4E+3)	7E-7	-	-	-
54	Xenon-120 ²	Submersion ¹	-	-	1E-5	4E-8	-	-
54	Xenon-121 ²	Submersion ¹	-	-	2E-6	1E-8	-	-
54	Xenon-122	Submersion ¹	-	-	7E-5	3E-7	-	-
54	Xenon-123	Submersion ¹	-	-	6E-6	3E-8	-	-
54	Xenon-126	Submersion ¹	-	-	2E-5	7E-8	-	-
54	Xenon-127	Submersion ¹	-	-	1E-5	6E-8	-	-
54	Xenon-129m	Submersion ¹	-	-	2E-4	9E-7	-	-
54	Xenon-131m	Submersion ¹	-	-	4E-4	2E-6	-	-
54	Xenon-133m	Submersion ¹	-	-	1E-4	6E-7	-	-
54	Xenon-133	Submersion ¹	-	-	1E-4	5E-7	-	-
54	Xenon-135m ²	Submersion ¹	-	-	9E-6	4E-8	-	-
54	Xenon-135	Submersion ¹	-	-	1E-5	7E-8	-	-
54	Xenon-138 ²	Submersion ¹	-	-	4E-6	2E-8	-	-
55	Cesium-125 ²	D, all compounds	5E+4 St. wall (9E+4)	1E+5	6E-5	2E-7	-	-
55	Cesium-127	D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion AI (μCi)	Inhalation		Col. 1 Air (μCi/m ³)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 All (μCi/yr)	Col. 3 DAC (μCi/ml)			
55	Cesium-129	D, all compounds	2E+4	3E+4	1E-5	5E-6	3E-4	3E-3
55	Cesium-130 ²	D, all compounds	6E+4 51 wall (1E+5)	2E+5	8E-5	3E-7	-	-
55	Cesium-131	D, all compounds	2E+4	3E+4	1E-5	4E-6	3E-4	3E-3
55	Cesium-132	D, all compounds	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
55	Cesium-134m	D, all compounds	1E+5 51 wall (1E+5)	1E+5	6E-5	2E-7	-	-
55	Cesium-134	D, all compounds	7E+1	1E+2	4E-8	2E-10	9E-7	9E-6
55	Cesium-135m ²	D, all compounds	1E+5	2E+5	8E-5	3E-7	1E-3	1E-2
55	Cesium-135	D, all compounds	7E+2	1E+3	9E-7	2E-9	1E-5	1E-4
55	Cesium-136	D, all compounds	4E+2	7E+2	3E-7	9E-10	6E-6	6E-5
55	Cesium-137	D, all compounds	1E+2	2E+2	6E-8	2E-10	1E-6	1E-5
55	Cesium-138 ²	D, all compounds	2E+4 51 wall (3E+4)	6E+4	2E-5	8E-8	-	-
56	Barium-126 ²	D, all compounds	6E+3	2E+4	6E-6	2E-8	8E-5	8E-4
56	Barium-128	D, all compounds	5E+2	2E+3	7E-7	2E-9	7E-6	7E-5
56	Barium-131m ²	D, all compounds	4E+5 51 wall (5E+5)	1E+6	6E-4	2E-6	-	-
56	Barium-131	D, all compounds	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
56	Barium-133m	D, all compounds	2E+3 LLI wall (3E+3)	9E+3	4E-6	1E-8	-	-
56	Barium-133	D, all compounds	2E+3	7E+2	3E-7	9E-10	2E-5	2E-4
56	Barium-135m	D, all compounds	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
56	Barium-135 ²	D, all compounds	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
56	Barium-140	D, all compounds	5E+2 LLI wall (6E+2)	1E+3	6E-7	2E-9	-	-
56	Barium-141 ²	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
56	Barium-142 ²	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
57	Lanthanum-131 ²	D, all compounds except those given for W	5E+4	1E+5	5E-5	7E-7	6E-4	6E-3
		W, oxides and hydroxides	-	2E+5	7E-5	2E-7	-	-

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
57	Lanthanum-132	D, see ¹³¹ La W, see ¹³¹ La	3E+3 -	1E+4 1E+4	4E-6 5E-6	1E-8 2E-8	4E-5 -	4E-4 -
57	Lanthanum-135	D, see ¹³¹ La W, see ¹³¹ La	4E+4 -	1E+5 9E+4	4E-5 4E-5	1E-7 1E-7	5E-4 -	5E-3 -
57	Lanthanum-137	D, see ¹³¹ La W, see ¹³¹ La	1E+4 -	6E+1 Liver (7E+1) 3E+2 Liver (3E+2)	3E-6 - 1E-7 -	- 1E-10 -	2E-4 -	2E-3 -
57	Lanthanum-138	D, see ¹³¹ La W, see ¹³¹ La	9E+2 -	4E+0 1E+1	1E-9 6E-9	5E-12 2E-11	1E-5 -	1E-4 -
57	Lanthanum-140	D, see ¹³¹ La W, see ¹³¹ La	6E+2 -	1E+3 1E+3	6E-7 5E-7	2E-9 2E-9	9E-6 -	9E-5 -
57	Lanthanum-141	D, see ¹³¹ La W, see ¹³¹ La	4E+3 -	9E+3 1E+4	4E-6 5E-6	1E-8 2E-8	5E-5 -	5E-4 -
57	Lanthanum-142 ¹	D, see ¹³¹ La W, see ¹³¹ La	8E+3 -	2E+4 3E+4	9E-6 1E-5	3E-8 5E-8	1E-4 -	1E-3 -
57	Lanthanum-143 ²	D, see ¹³¹ La W, see ¹³¹ La	4E+4 St. wall (4E+4) -	1E+5 -	4E-6 -	1E-7 -	- 5E-4	- 5E-3
58	Cerium-134	Y, all compounds except those given for Y Y, oxide, hydroxides, and fluorides	5E+2 LLI wall (6E+2) -	7E+2 -	3E-7 -	1E-9 -	- 8E-6	- 8E-5
58	Cerium-135	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	2E+3 -	4E+3 4E+3	2E-6 1E-6	5E-9 5E-9	2E-5 -	2E-4 -
58	Cerium-137m	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	2E+3 LLI wall (2E+3) -	4E+3 -	2E-6 -	6E-9 5E-9	- 3E-5	- 3E-4
58	Cerium-137	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	5E+4 -	1E+5 1E+5	6E-5 5E-5	2E-7 2E-7	7E-4 -	7E-3 -
58	Cerium-139	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	5E+3 -	8E+2 7E+2	3E-7 3E-7	1E-9 9E-10	7E-5 -	7E-4 -
58	Cerium-141	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	2E+3 LLI wall (2E+3) -	7E+2 -	3E-7 -	1E-9 -	- 3E-5	- 3E-4
58	Cerium-143	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	1E+3 LLI wall (1E+3) -	2E+3 -	8E-7 -	3E-9 -	- 2E-5	- 2E-4

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{m}^3$)	Col. 2 Water ($\mu\text{Ci}/\text{m}^3$)	Monthly Average Concentration ($\mu\text{Ci}/\text{m}^3$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{m}^3$)			
58	Cerium-144	W, see ^{134}Ce	$2\text{E}+2$ LLI wall ($3\text{E}+2$)	$3\text{E}+1$	$1\text{E}-8$	$4\text{E}-11$	-	-
		Y, see ^{134}Ce	-	$1\text{E}+1$	$6\text{E}-9$	$2\text{E}-11$	$3\text{E}-6$	$3\text{E}-5$
59	Praseodymium-136 ²	W, all compounds except those given for Y	$5\text{E}+4$ St. wall ($7\text{E}+4$)	$2\text{E}+5$	$1\text{E}-4$	$3\text{E}-7$	-	-
		Y, oxides, hydroxides, carbides, and fluorides	-	$2\text{E}+5$	$9\text{E}-5$	$3\text{E}-7$	-	-
59	Praseodymium-137 ²	W, see ^{136}Pr	$4\text{E}+4$	$2\text{E}+5$	$6\text{E}-5$	$2\text{E}-7$	$5\text{E}-4$	$5\text{E}-3$
		Y, see ^{136}Pr	-	$1\text{E}+5$	$6\text{E}-5$	$2\text{E}-7$	-	-
59	Praseodymium-138m	W, see ^{136}Pr	$1\text{E}+4$	$5\text{E}+4$	$2\text{E}-5$	$8\text{E}-8$	$1\text{E}-4$	$1\text{E}-3$
		Y, see ^{136}Pr	-	$4\text{E}+4$	$2\text{E}-5$	$6\text{E}-8$	-	-
59	Praseodymium-139	W, see ^{136}Pr	$4\text{E}+6$	$1\text{E}+5$	$5\text{E}-5$	$2\text{E}-7$	$6\text{E}-8$	$6\text{E}-3$
		Y, see ^{136}Pr	-	$1\text{E}+5$	$5\text{E}-5$	$7\text{E}-7$	-	-
59	Praseodymium-142m ²	W, see ^{136}Pr	$8\text{E}+4$	$2\text{E}+5$	$7\text{E}-5$	$1\text{E}-7$	$1\text{E}-3$	$1\text{E}-2$
		Y, see ^{136}Pr	-	$1\text{E}+5$	$6\text{E}-5$	$2\text{E}-7$	-	-
59	Praseodymium-142	W, see ^{136}Pr	$1\text{E}+3$	$2\text{E}+3$	$9\text{E}-7$	$3\text{E}-9$	$1\text{E}-5$	$1\text{E}-4$
		Y, see ^{136}Pr	-	$2\text{E}+3$	$8\text{E}-7$	$3\text{E}-9$	-	-
59	Praseodymium-143	W, see ^{136}Pr	$9\text{E}+2$ LLI wall ($1\text{E}+3$)	$8\text{E}+2$	$3\text{E}-7$	$1\text{E}-9$	-	-
		Y, see ^{136}Pr	-	$7\text{E}+2$	$3\text{E}-7$	$9\text{E}-10$	$2\text{E}-5$	$2\text{E}-4$
59	Praseodymium-144 ²	W, see ^{136}Pr	$3\text{E}+4$ St. wall ($4\text{E}+4$)	$1\text{E}+5$	$5\text{E}-5$	$2\text{E}-7$	-	-
		Y, see ^{136}Pr	-	$1\text{E}+5$	$5\text{E}-5$	$2\text{E}-7$	$6\text{E}-4$	$6\text{E}-3$
59	Praseodymium-145	W, see ^{136}Pr	$3\text{E}+3$	$9\text{E}+3$	$4\text{E}-6$	$1\text{E}-8$	$4\text{E}-5$	$4\text{E}-4$
		Y, see ^{136}Pr	-	$8\text{E}+3$	$3\text{E}-6$	$1\text{E}-8$	-	-
59	Praseodymium-147 ²	W, see ^{136}Pr	$5\text{E}+4$ St. wall ($8\text{E}+4$)	$2\text{E}+5$	$8\text{E}-5$	$3\text{E}-7$	-	-
		Y, see ^{136}Pr	-	$2\text{E}+5$	$8\text{E}-5$	$3\text{E}-7$	$1\text{E}-3$	$1\text{E}-2$
60	Neodymium-136 ²	W, all compounds except those given for Y	$1\text{E}+4$	$6\text{E}+4$	$2\text{E}-5$	$8\text{E}-8$	$2\text{E}-4$	$2\text{E}-3$
		Y, oxides, hydroxides, carbides, and fluorides	-	$5\text{E}+4$	$2\text{E}-5$	$8\text{E}-8$	-	-
60	Neodymium-138	W, see ^{136}Nd	$2\text{E}+3$	$6\text{E}+3$	$3\text{E}-6$	$9\text{E}-9$	$3\text{E}-5$	$3\text{E}-4$
		Y, see ^{136}Nd	-	$5\text{E}+3$	$2\text{E}-6$	$7\text{E}-9$	-	-
60	Neodymium-139m	W, see ^{136}Nd	$5\text{E}+3$	$2\text{E}+4$	$7\text{E}-6$	$2\text{E}-8$	$7\text{E}-5$	$7\text{E}-4$
		Y, see ^{136}Nd	-	$1\text{E}+4$	$6\text{E}-6$	$2\text{E}-8$	-	-

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
			Ingestion	Inhalation		Air (μCi/ml)	Water (μCi/ml)	
			All (μCi)	All (μCi)	DAC (μCi/ml)			
60	Neodymium-139 ²	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	9E+4 -	3E+5 3E+5	1E-4 1E-4	5E-7 4E-7	1E-3 -	1E-2 -
60	Neodymium-141	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	2E+5 -	7E+5 6E+5	3E-4 3E-4	1E-6 9E-7	2E-3 -	2E-2 -
60	Neodymium-147	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	1E+3 LLI wall (1E+3) -	9E+2 -	4E-7 -	1E-9 -	- 2E-5 -	- 2E-4 -
60	Neodymium-149 ²	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	1E+4 -	3E+4 2E+4	1E-5 1E-5	4E-8 3E-8	1E-4 -	1E-3 -
60	Neodymium-151 ²	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	7E+4 -	2E+5 2E+5	8E-5 8E-5	3E-7 3E-7	9E-4 -	9E-3 -
61	Promethium-141 ²	W, all compounds except those given for Y Y, oxides, hydroxides, carbides, and fluorides	5E+4 St. wall (6E+4) -	2E+5 -	8E-5 -	3E-7 -	- 8E-4 -	- 8E-3 -
61	Promethium-143	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	5E+3 -	6E+2 7E+2	2E-7 3E-7	8E-10 1E-9	7E-5 -	7E-4 -
61	Promethium-144	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	1E+3 -	1E+2 1E+2	5E-8 5E-8	2E-10 2E-10	2E-5 -	2E-4 -
61	Promethium-145	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	1E+4 -	2E+2 Bone surf (2E+2) 2E+2	7E-8 -	- 3E-10 3E-10	1E-4 -	1E-3 -
61	Promethium-146	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	2E+3 -	5E+1 4E+1	2E-8 2E-8	7E-11 6E-11	2E-5 -	2E-4 -
61	Promethium-147	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	4E+3 LLI wall (5E+3) -	1E+2 Bone surf (2E+2) 1E+2	5E-8 -	- 3E-10 2E-10	- 7E-5 -	- 7E-4 -
61	Promethium-148m	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	7E+2 -	3E+2 3E+2	1E-7 1E-7	4E-10 5E-10	1E-5 -	1E-4 -
61	Promethium-148	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	4E+2 LLI wall (5E+2) -	5E+2 -	2E-7 -	8E-10 -	- 7E-6 -	- 7E-5 -
61	Promethium-149	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	1E+3 LLI wall (1E+3) -	2E+3 -	8E-7 -	3E-9 -	- 2E-5 -	- 2E-4 -
61	Promethium-150	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	5E+3 -	2E+4 2E+4	8E-6 7E-6	3E-8 2E-8	7E-5 -	7E-4 -
61	Promethium-151	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	2E+3 -	4E+3 3E+3	1E-6 1E-6	5E-9 4E-9	2E-5 -	2E-4 -

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
62	Samarium-141 ²	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
62	Samarium-141 ²	W, all compounds	5E+4 St. wall (6E+4)	2E+5	8E-5	2E-7	-	-
62	Samarium-142 ²	W, all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
62	Samarium-145	W, all compounds	6E+3	5E+2	2E-7	7E-10	8E-5	8E-4
62	Samarium-146	W, all compounds	1E+1 Bone surf (3E+1)	4E+2 Bone surf (6E+2)	1E-11	-	-	-
62	Samarium-147	W, all compounds	2E+1 Bone surf (3E+1)	4E+2 Bone surf (7E+2)	2E-11	-	-	-
62	Samarium-151	W, all compounds	1E+4 L11 wall (1E+4)	1E+2 Bone surf (2E+2)	4E-8	-	-	-
62	Samarium-153	W, all compounds	2E+3 L11 wall (2E+3)	3E+3	1E-6	4E-9	-	-
62	Samarium-155 ²	W, all compounds	6E+4 St. wall (8E+4)	2E+5	9E-5	3E-7	-	-
62	Samarium-156	W, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
63	Europium-145	W, all compounds	2E+3	2E+3	8E-7	3E-9	2E-5	2E-4
63	Europium-146	W, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
63	Europium-147	W, all compounds	3E+3	2E+3	7E-7	2E-9	4E-5	4E-4
63	Europium-148	W, all compounds	1E+3	4E+2	1E-7	5E-10	1E-5	1E-4
63	Europium-149	W, all compounds	1E+4	3E+3	1E-6	4E-9	2E-4	2E-3
63	Europium-150 (12.62 h)	W, all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
63	Europium-150 (34.2 y)	W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
63	Europium-152a	W, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
63	Europium-152	W, all compounds	8E+2	2E+1	1E-8	3E-11	1E-5	1E-4
63	Europium-154	W, all compounds	5E+2	2E+1	8E-9	3E-11	7E-6	7E-5
63	Europium-155	W, all compounds	4E+3	9E+1 Bone surf (1E+2)	4E-8	-	5E-5	5E-4
63	Europium-156	W, all compounds	-	-	-	2E-10	-	-
63	Europium-156	W, all compounds	6E+2	5E+2	2E-7	6E-10	8E-6	8E-5

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion AI (μCi)	Col. 2 Inhalation AI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)	Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
63	Europium-157	W, all compounds	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
63	Europium-158 ²	W, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
64	Gadolinium-145 ²	D, all compounds except those given for W	5E+4 St. wall (5E+4)	1E+5	6E-5	2E-7	-	-
		W, oxides, hydroxides, and fluorides	-	2E+5	7E-5	2E-7	6E-4	6E-3
64	Gadolinium-146	D, see ¹⁴⁵ Gd	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		W, see ¹⁴⁵ Gd	-	3E+2	1E-7	4E-10	-	-
64	Gadolinium-147	D, see ¹⁴⁵ Gd	2E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		W, see ¹⁴⁵ Gd	-	4E+3	1E-6	5E-9	-	-
64	Gadolinium-148	D, see ¹⁴⁵ Gd	1E+1 Bone surf (2E+1)	8E+3 Bone surf (2E+2)	3E-12	-	-	-
		W, see ¹⁴⁵ Gd	-	3E+2 Bone surf (6E+2)	1E-11	2E-14	3E-7	3E-6
64	Gadolinium-149	D, see ¹⁴⁵ Gd	3E+3	2E+3	9E-7	3E-9	4E-5	4E-4
		W, see ¹⁴⁵ Gd	-	2E+3	1E-6	3E-9	-	-
64	Gadolinium-151	D, see ¹⁴⁵ Gd	6E+3	4E+2 Bone surf (6E+2)	2E-7	-	9E-5	9E-4
		W, see ¹⁴⁵ Gd	-	1E+3	5E-7	9E-10	-	-
64	Gadolinium-152	D, see ¹⁴⁵ Gd	2E+1 Bone surf (3E+1)	1E-2 Bone surf (2E-2)	4E-12	-	-	-
		W, see ¹⁴⁵ Gd	-	4E-2 Bone surf (8E-2)	2E-11	3E-14	4E-7	4E-6
64	Gadolinium-153	D, see ¹⁴⁵ Gd	5E+3	1E+2 Bone surf (2E+2)	6E-8	-	6E-5	6E-4
		W, see ¹⁴⁵ Gd	-	6E+2	2E-7	3E-10	-	-
64	Gadolinium-159	D, see ¹⁴⁵ Gd	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ¹⁴⁵ Gd	-	6E+3	2E-6	8E-9	-	-
65	Terbium-147 ²	W, all compounds	9E+3	3E+4	1E-5	5E-8	1E-4	1E-3
65	Terbium-149	W, all compounds	5E+3	7E+2	3E-7	1E-9	7E-5	7E-4
65	Terbium-150	W, all compounds	9E+3	2E+4	9E-6	3E-8	7E-5	7E-4
65	Terbium-151	W, all compounds	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
65	Terbium-153	W, all compounds	5E+3	7E+3	3E-6	1E-8	7E-5	7E-4
65	Terbium-154	W, all compounds	2E+3	4E+3	2E-6	6E-9	2E-5	2E-4
65	Terbium-155	W, all compounds	6E+3	8E+3	3E-6	1E-8	8E-5	8E-4
65	Terbium-156m (5.0 h)	W, all compounds	2E+4	3E+4	1E-5	4E-8	2E-4	2E-3

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
			Oral Ingestion ALI (μCi)	Inhalation		Air ($\mu\text{Ci}/\text{ml}$)	Water ($\mu\text{Ci}/\text{ml}$)	
				ALI (μCi)	DAE ($\mu\text{Ci}/\text{ml}$)			
65	Terbium-156m (24 h)	W, all compounds	$7\text{E}+3$	$8\text{E}+3$	$3\text{E}+6$	$1\text{E}+8$	$1\text{E}+4$	$1\text{E}+3$
65	Terbium-156	W, all compounds	$1\text{E}+3$	$1\text{E}+3$	$6\text{E}+7$	$2\text{E}+9$	$1\text{E}+5$	$1\text{E}+4$
65	Terbium-157	W, all compounds	$5\text{E}+4$ LLI wall ($5\text{E}+4$)	$3\text{E}+2$ Bone surf ($4\text{E}+2$)	$1\text{E}+7$	-	-	-
65	Terbium-158	W, all compounds	$1\text{E}+3$	$2\text{E}+1$	$8\text{E}+9$	$3\text{E}+11$	$2\text{E}+5$	$2\text{E}+4$
65	Terbium-160	W, all compounds	$8\text{E}+2$	$2\text{E}+2$	$9\text{E}+8$	$3\text{E}+10$	$1\text{E}+5$	$1\text{E}+4$
65	Terbium-161	W, all compounds	$2\text{E}+3$ LLI wall ($2\text{E}+3$)	$2\text{E}+3$	$7\text{E}+7$	$2\text{E}+9$	-	-
66	Dysprosium-155	W, all compounds	$9\text{E}+3$	$3\text{E}+4$	$1\text{E}+5$	$4\text{E}+8$	$1\text{E}+4$	$1\text{E}+3$
66	Dysprosium-157	W, all compounds	$2\text{E}+4$	$6\text{E}+4$	$3\text{E}+5$	$9\text{E}+8$	$3\text{E}+4$	$1\text{E}+3$
66	Dysprosium-159	W, all compounds	$1\text{E}+4$	$2\text{E}+3$	$1\text{E}+6$	$3\text{E}+9$	$2\text{E}+4$	$2\text{E}+3$
66	Dysprosium-165	W, all compounds	$1\text{E}+4$	$5\text{E}+4$	$2\text{E}+5$	$6\text{E}+8$	$2\text{E}+4$	$2\text{E}+3$
66	Dysprosium-166	W, all compounds	$6\text{E}+2$ LLI wall ($8\text{E}+2$)	$7\text{E}+2$	$3\text{E}+7$	$1\text{E}+9$	-	-
67	Holmium-155 ²	W, all compounds	$4\text{E}+4$	$2\text{E}+5$	$6\text{E}+5$	$2\text{E}+7$	$6\text{E}+4$	$6\text{E}+3$
67	Holmium-157 ²	W, all compounds	$3\text{E}+5$	$1\text{E}+6$	$6\text{E}+4$	$2\text{E}+6$	$4\text{E}+3$	$4\text{E}+2$
67	Holmium-159 ²	W, all compounds	$2\text{E}+5$	$1\text{E}+6$	$4\text{E}+4$	$1\text{E}+6$	$3\text{E}+3$	$3\text{E}+2$
67	Holmium-161	W, all compounds	$1\text{E}+5$	$4\text{E}+5$	$2\text{E}+4$	$6\text{E}+7$	$1\text{E}+3$	$1\text{E}+2$
67	Holmium-162m ²	W, all compounds	$5\text{E}+4$	$3\text{E}+5$	$1\text{E}+4$	$4\text{E}+7$	$7\text{E}+4$	$7\text{E}+3$
67	Holmium-162 ²	W, all compounds	$5\text{E}+5$ St. wall ($8\text{E}+5$)	$2\text{E}+6$	$1\text{E}+3$	$3\text{E}+6$	-	-
67	Holmium-164m ²	W, all compounds	$1\text{E}+5$	$3\text{E}+5$	$1\text{E}+4$	$4\text{E}+7$	$1\text{E}+3$	$1\text{E}+2$
67	Holmium-164 ²	W, all compounds	$2\text{E}+5$ St. wall ($2\text{E}+5$)	$6\text{E}+5$	$3\text{E}+4$	$9\text{E}+7$	-	-
67	Holmium-166m	W, all compounds	$6\text{E}+2$	$7\text{E}+0$	$3\text{E}+9$	$9\text{E}+12$	$9\text{E}+6$	$9\text{E}+5$
67	Holmium-166	W, all compounds	$9\text{E}+2$ LLI wall ($9\text{E}+2$)	$2\text{E}+3$	$7\text{E}+7$	$2\text{E}+9$	-	-
67	Holmium-167	W, all compounds	$2\text{E}+4$	$6\text{E}+4$	$2\text{E}+5$	$8\text{E}+8$	$2\text{E}+4$	$2\text{E}+3$
68	Erbium-161	W, all compounds	$2\text{E}+4$	$6\text{E}+4$	$3\text{E}+5$	$9\text{E}+8$	$2\text{E}+4$	$2\text{E}+3$
68	Erbium-165	W, all compounds	$6\text{E}+4$	$2\text{E}+5$	$8\text{E}+5$	$3\text{E}+7$	$9\text{E}+4$	$9\text{E}+3$

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Dose Ingestion ALI (μ Ci)	Inhalation		Col. 1 Air (μ Ci/ml)	Col. 2 Water (μ Ci/ml)	Monthly Average Concentration (μ Ci/ml)
				Col. 2 ALI (μ Ci)	Col. 3 DAC (μ Ci/ml)			
68	Erbium-169	W, all compounds	$3E+3$ LLI wall ($4E+3$)	$3E+3$	$1E-6$	$4E-9$	-	-
68	Erbium-171	W, all compounds	$4E+3$	$1E+4$	$4E-6$	$1E-8$	$5E-5$	$5E-4$
68	Erbium-172	W, all compounds	$1E+3$ LLI wall ($1E+3$)	$1E+3$	$6E-7$	$2E-9$	-	-
69	Thulium-162 ²	W, all compounds	$7E+4$ St. wall ($7E+4$)	$3E+5$	$1E-4$	$4E-7$	-	-
69	Thulium	W, all compounds	$4E+3$	$1E+4$	$6E-6$	$2E-8$	$6E-5$	$6E-4$
69	Thulium-167	W, all compounds	$2E+3$ LLI wall ($2E+3$)	$2E+3$	$8E-7$	$3E-9$	-	-
69	Thulium-170	W, all compounds	$8E+2$ LLI wall ($1E+3$)	$2E+2$	$9E-8$	$3E-10$	-	-
69	Thulium-171	W, all compounds	$1E+4$ LLI wall ($1E+4$)	$3E+2$ Bone surf ($6E+2$)	$1E-7$	-	$8E-10$	$2E-3$
69	Thulium-172	W, all compounds	$7E+2$ LLI wall ($8E+2$)	$1E+3$	$5E-7$	$2E-9$	-	-
69	Thulium-173	W, all compounds	$4E+3$	$1E+4$	$5E-6$	$2E-8$	$6E-5$	$6E-4$
69	Thulium-175 ²	W, all compounds	$7E+4$ St. wall ($9E+4$)	$3E+5$	$1E-4$	$4E-7$	-	-
70	Ytterbium-162 ²	W, all compounds except those given for Y	$7E+4$	$3E+5$	$1E-4$	$4E-7$	$1E-3$	$1E-2$
		Y, oxides, hydroxides, and fluorides	-	$3E+5$	$1E-4$	$4E-7$	-	-
70	Ytterbium-166	W, see 162Yb Y, see 162Yb	$1E+3$	$2E+3$ $2E+3$	$8E-7$ $8E-7$	$3E-9$ $3E-9$	$2E-5$	$2E-4$
70	Ytterbium-167 ²	W, see 162Yb Y, see 162Yb	$3E+5$	$8E+5$ $7E+5$	$3E-4$ $3E-4$	$1E-6$ $1E-6$	$4E-3$	$4E-2$
70	Ytterbium-169	W, see 162Yb Y, see 162Yb	$2E+3$	$8E+2$ $7E+2$	$4E-7$ $3E-7$	$1E-9$ $1E-9$	$2E-5$	$2E-4$
70	Ytterbium-175	W, see 162Yb	$3E+3$ LLI wall ($3E+3$)	$4E+3$	$1E-6$	$5E-9$	-	-
		Y, see 162Yb	-	$3E+3$	$1E-6$	$5E-9$	$4E-5$	$4E-4$
70	Ytterbium-177 ²	W, see 162Yb Y, see 162Yb	$2E+4$	$5E+4$ $5E+4$	$2E-5$ $2E-5$	$7E-8$ $6E-8$	$2E-4$	$2E-3$
70	Ytterbium-178 ²	W, see 162Yb Y, see 162Yb	$1E+4$	$4E+4$ $4E+4$	$2E-5$ $2E-5$	$6E-8$ $5E-8$	$2E-4$	$2E-3$

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μ Ci)	Inhalation		Col. 1 Air (μ Ci/m ³)	Col. 2 Water (μ Ci/ml)	Monthly Average Concentration (μ Ci/ml)
				Col. 2 ALI (μ Ci)	Col. 3 DAC (μ Ci/ml)			
71	Lutetium-169	W, all compounds except those given for Y	3E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		Y, oxides, hydroxides, and fluorides	-	4E+3	2E-6	6E-9	-	-
71	Lutetium-170	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	1E+3	2E+3 2E+3	9E-7 8E-7	3E-9 3E-9	2E-5 -	2E-4 -
71	Lutetium-171	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	2E+3 -	2E+3 2E+3	8E-7 8E-7	3E-9 3E-9	3E-5 -	3E-4 -
71	Lutetium-172	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	1E+3 -	1E+3 1E+3	5E-7 5E-7	2E-9 2E-9	1E-5 -	1E-4 -
71	Lutetium-173	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	5E+3 -	3E+2 Bone surf (5E+2) 3E+2	1E-7 - 1E-7	- 6E-10 4E-10	7E-5 - -	7E-4 - -
71	Lutetium-174m	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	2E+3 (3E+3) -	2E+2 Bone surf (3E+2) 2E+2	1E-7 - 9E-8	- 5E-10 3E-10	- 4E-5 -	- 4E-4 -
71	Lutetium-174	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	5E+3 -	1E+2 Bone surf (2E+2) 2E+2	5E-8 - 6E-8	- 3E-10 2E-10	7E-5 - -	7E-4 - -
71	Lutetium-176m	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	8E+3 -	3E+4 2E+4	1E-5 9E-6	3E-8 3E-8	1E-4 -	1E-3 -
71	Lutetium-176	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	7E+2 -	5E+0 Bone surf (1E+1) 8E+0	2E-9 - 3E-9	- 2E-11 1E-11	1E-5 - -	1E-4 - -
71	Lutetium-177m	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	7E+2 -	1E+2 Bone surf (1E+2) 8E+1	5E-8 - 3E-8	- 2E-10 1E-10	1E-5 - -	1E-4 - -
71	Lutetium-177	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	2E+3 LLI wall (3E+3) -	2E+3 - 2E+3	9E-7 - 9E-7	3E-9 - 3E-9	- 4E-5 -	- 4E-4 -
71	Lutetium-178m ²	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	5E+4 St. wall (6E+4) -	2E+5 - 2E+5	8E-5 - 7E-5	3E-7 - 2E-7	- 8E-4 -	- 8E-3 -
71	Lutetium-178 ²	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	4E+4 St. wall (4E+4) -	1E+5 - 1E+5	5E-5 - 5E-5	2E-7 - 2E-7	- 6E-4 -	- 6E-3 -
71	Lutetium-179	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	6E+3 -	2E+4 2E+4	8E-6 6E-6	3E-8 3E-8	9E-5 -	9E-4 -

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Dose Ingestion AI (μ Ci)	Inhalation		Col. 1 Air (μ Ci/ml)	Col. 2 Water (μ Ci/ml)	Monthly Average Concentration (μ Ci/ml)
				Col. 2 AI (μ Ci)	Col. 3 DAC (μ Ci/ml)			
72	Hafnium-170	D, all compounds except those given for W	3E+3	6E+3	2E-6	8E-9	4E-5	4E-4
		W, oxides, hydroxides, carbides, and nitrates	-	5E+3	2E-6	6E-9	-	-
72	Hafnium-172	D, see ^{170}Hf	1E+3	9E+0 Bone surf	4E-9	-	2E-5	2E-4
		W, see ^{170}Hf	-	(2E+1) 4E+1 Bone surf	- 2E-8	3E-11 -	- -	- -
			-	(6E+1)	-	8E-11	-	-
72	Hafnium-173	D, see ^{170}Hf	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{170}Hf	-	1E+4	5E-6	2E-8	-	-
72	Hafnium-175	D, see ^{170}Hf	3E+3	9E+2 Bone surf	4E-7	-	4E-5	4E-4
		W, see ^{170}Hf	-	(1E+3) 1E+3	- 5E-7	1E-9 2E-9	- -	- -
72	Hafnium-177m ²	D, see ^{170}Hf	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		W, see ^{170}Hf	-	9E+4	4E-5	1E-7	-	-
72	Hafnium-178m	D, see ^{170}Hf	3E+2	1E+0 Bone surf	5E-10	-	3E-6	3E-5
		W, see ^{170}Hf	-	(2E+0) 5E+0 Bone surf	- 2E-9	3E-12 -	- -	- -
			-	(9E+0)	-	1E-11	-	-
72	Hafnium-179m	D, see ^{170}Hf	1E+3	3E+2 Bone surf	1E-7	-	1E-5	1E-4
		W, see ^{170}Hf	-	(6E+2) 6E+2	- 3E-7	8E-10 8E-10	- -	- -
72	Hafnium-180m	D, see ^{170}Hf	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{170}Hf	-	3E+4	1E-5	4E-8	-	-
72	Hafnium-181	D, see ^{170}Hf	1E+3	2E+2 Bone surf	7E-8	-	2E-5	2E-4
		W, see ^{170}Hf	-	(4E+2) 4E+2	- 2E-7	6E-10 6E-10	- -	- -
72	Hafnium-182m ²	D, see ^{170}Hf	4E+4	9E+4	4E-5	1E-7	5E-4	5E-3
		W, see ^{170}Hf	-	1E+5	6E-5	2E-7	-	-
72	Hafnium-182	D, see ^{170}Hf	2E+2 Bone surf	8E-1 Bone surf	3E-10	-	-	-
		W, see ^{170}Hf	(4E+2) -	(2E+0) 3E+0 Bone surf	- 1E-9	2E-12 -	5E-6 -	5E-5 -
			-	(7E+0)	-	1E-11	-	-
72	Hafnium-183 ²	D, see ^{170}Hf	2E+4	5E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{170}Hf	-	6E+4	2E-5	8E-8	-	-
72	Hafnium-184	D, see ^{170}Hf	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		W, see ^{170}Hf	-	6E+3	3E-6	9E-9	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion AL (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{m}^3$)	Col. 2 Water ($\mu\text{Ci}/\text{m}^3$)	Monthly Average Concentration ($\mu\text{Ci}/\text{m}^3$)
				Col. 2 ALL (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{m}^3$)			
73	Tantalum-172 ²	W, all compounds except those given for Y	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
		Y, elemental Ta, oxides, hydroxides, halides, carbides, nitrates, and nitrides	-	1E+5	4E-5	1E-7	-	-
73	Tantalum-173	W, see 172Ta Y, see 172Ta	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
			-	2E+4	7E-6	2E-8	-	-
73	Tantalum-174 ²	W, see 172Ta Y, see 172Ta	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
			-	9E+4	4E-5	1E-7	-	-
73	Tantalum-175	W, see 172Ta Y, see 172Ta	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
			-	1E+4	6E-6	2E-8	-	-
73	Tantalum-176	W, see 172Ta Y, see 172Ta	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
			-	1E+4	5E-6	2E-8	-	-
73	Tantalum-177	W, see 172Ta Y, see 172Ta	1E+4	2E+4	8E-6	3E-8	2E-4	2E-3
			-	2E+4	7E-6	2E-8	-	-
73	Tantalum-178	W, see 172Ta Y, see 172Ta	2E+4	9E+4	4E-5	1E-7	2E-4	2E-3
			-	7E+4	3E-5	1E-7	-	-
73	Tantalum-179	W, see 172Ta Y, see 172Ta	2E+4	5E+3	2E-6	8E-9	3E-4	3E-3
			-	9E+2	4E-7	1E-9	-	-
73	Tantalum-180m	W, see 172Ta Y, see 172Ta	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
			-	6E+4	2E-5	8E-8	-	-
73	Tantalum-180	W, see 172Ta Y, see 172Ta	1E+3	4E+2	2E-7	6E-10	2E-5	2E-4
			-	2E+1	1E-8	3E-11	-	-
73	Tantalum-182m ²	W, see 172Ta	2E+5	5E+5	2E-4	8E-7	-	-
		St. wall	(2E+5)	-	-	-	-	-
		Y, see 172Ta	-	4E+5	2E-4	6E-7	3E-3	3E-2
73	Tantalum-182	W, see 172Ta Y, see 172Ta	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
			-	1E+2	6E-8	2E-10	-	-
73	Tantalum-183	W, see 172Ta	9E+2	1E+3	5E-7	2E-9	-	-
		LLL wall	(1E+3)	-	-	-	-	-
		Y, see 172Ta	-	1E+3	4E-7	1E-9	2E-5	2E-4
73	Tantalum-184	W, see 172Ta Y, see 172Ta	2E+3	5E+3	2E-6	8E-9	3E-5	3E-4
			-	5E+3	2E-6	7E-9	-	-
73	Tantalum-185 ²	W, see 172Ta Y, see 172Ta	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
			-	6E+4	3E-5	9E-8	-	-
73	Tantalum-186 ²	W, see 172Ta	5E+4	2E+5	1E-4	3E-7	-	-
		St. wall	(7E+4)	-	-	-	-	-
		Y, see 172Ta	-	2E+5	9E-5	3E-7	1E-3	1E-2
74	Tungsten-176	D, all compounds	1E+4	5E+4	2E-5	7E-8	1E-4	1E-3
74	Tungsten-177	D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
			Col. 1 Oral Ingestion ALI (μCi)	Col. 3 Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)	
				Col. 2 ALI (μCi)	DAC				
74	Tungsten-178	D, all compounds	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4	
74	Tungsten-179 ²	D, all compounds	5E+5	2E+6	7E-4	2E-6	7E-3	7E-2	
74	Tungsten-181	D, all compounds	2E+4	3E+4	1E-5	5E-8	2E-4	2E-3	
74	Tungsten-185	D, all compounds	2E+3 LLI wall (3E+3)	7E+3	3E-6	9E-9	-	-	
74	Tungsten-187	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4	
74	Tungsten-188	D, all compounds	4E+2 LLI wall (5E+2)	1E+3	5E-7	2E-9	-	-	
75	Rhenium-177 ²	D, all compounds except those given for W	9E+4 St. wall (1E+5)	3E+5	1E-4	4E-7	-	-	
		W, oxides, hydroxides, and nitrates	-	4E+5	1E-4	5E-7	-	-	
75	Rhenium-178 ²	D, see ¹⁷⁷ Re	7E+4 St. wall (1E+5)	3E+5	1E-4	4E-7	-	-	
		W, see ¹⁷⁷ Re	-	3E+5	1E-4	4E-7	-	-	
75	Rhenium-181	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	5E+3 -	9E+3 9E+3	4E-6 4E-6	1E-8 1E-8	7E-5 -	7E-4 -	
75	Rhenium-182 (12.7 h)	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	7E+3 -	1E+4 2E+4	5E-6 6E-6	2E-8 2E-8	9E-5 -	9E-4 -	
75	Rhenium-182 (64.0 h)	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	1E+3 -	2E+3 2E+3	1E-6 9E-7	3E-9 3E-9	2E-5 -	2E-4 -	
75	Rhenium-184a	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	2E+3 -	3E+3 4E+2	1E-6 2E-7	4E-9 6E-10	3E-5 -	3E-4 -	
75	Rhenium-184	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	2E+3 -	4E+3 1E+3	1E-6 6E-7	5E-9 2E-9	3E-5 -	3E-4 -	
75	Rhenium-186a	D, see ¹⁷⁷ Re	1E+3 St. wall (2E+3)	2E+3 St. wall (2E+3)	7E-7 -	-	-	-	
		W, see ¹⁷⁷ Re	-	2E+2	6E-8	3E-9 2E-10	2E-5 -	2E-4 -	
75	Rhenium-186	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	2E+3 -	3E+3 2E+3	1E-6 7E-7	4E-9 2E-9	3E-5 -	3E-4 -	
75	Rhenium-187	D, see ¹⁷⁷ Re	6E+5	1E+5 St. wall (9E+5)	4E-4	-	8E-3	8E-2	
		W, see ¹⁷⁷ Re	-	1E+5	4E-5	1E-7	-	-	
75	Rhenium-188a ²	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	8E+4 -	1E+5 1E+5	6E-5 6E-5	2E-7 2E-7	1E-3 -	1E-2 -	
75	Rhenium-188	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	2E+3 -	3E+3 3E+3	1E-6 1E-6	4E-9 4E-9	2E-5 -	2E-4 -	

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{m}^3$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
75	Rhenium-189	D, see 177Re W, see 177Re	1E+3	5E+3	2E-6	7E-7	1E-5	4E-4
76	Osmium-180 ²	D, all compounds except those given for W and Y W, halides and nitrates Y, oxides and hydroxides	1E+5	4E+5	2E-4	5E-7	1E-3	1E-2
76	Osmium-181 ²	D, see 180Os W, see 180Os Y, see 180Os	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
76	Osmium-182	D, see 180Os W, see 180Os Y, see 180Os	1E+3	5E+3	2E-6	8E-9	3E-5	3E-4
76	Osmium-185	D, see 180Os W, see 180Os Y, see 180Os	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
76	Osmium-189m	D, see 180Os W, see 180Os Y, see 180Os	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
76	Osmium-191m	D, see 180Os W, see 180Os Y, see 180Os	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
76	Osmium-191	D, see 180Os W, see 180Os Y, see 180Os	2E+3	2E+3	9E-7	3E-9	-	-
76	Osmium-193	D, see 180Os W, see 180Os Y, see 180Os	2E+3	5E+3	2E-6	6E-9	-	-
76	Osmium-194	D, see 180Os W, see 180Os Y, see 180Os	4E+2	4E+1	2E-8	6E-11	-	-
77	Iridium-182 ²	D, all compounds except those given for W and Y W, halides, nitrates, and metallic iridium Y, oxides and hydroxides	4E+4 St. wall (4E+4)	1E+5	6E-5	2E-7	-	-
77	Iridium-184	D, see 182Ir W, see 182Ir Y, see 182Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{m}^3$)	Col. 2 Water ($\mu\text{Ci}/\text{m}^3$)	Monthly Average Concentration ($\mu\text{Ci}/\text{m}^3$)
				ALI (μCi)	DAC ($\mu\text{Ci}/\text{m}^3$)			
77	Iridium-185	D, see 182Ir W, see 182Ir Y, see 182Ir	5E+3 - -	1E+4 1E+4 1E+4	5E+6 5E+6 4E+6	2E-8 2E-8 1E-8	7E-5 - -	7E-4 - -
77	Iridium-186	D, see 182Ir W, see 182Ir Y, see 182Ir	2E+3 - -	8E+3 6E+3 6E+3	3E+6 3E+6 2E+6	1E-8 9E-9 8E-9	3E-5 - -	3E-4 - -
77	Iridium-187	D, see 182Ir W, see 182Ir Y, see 182Ir	1E+4 - -	3E+4 3E+4 3E+4	1E+5 1E+5 1E+5	5E-8 4E-8 4E-8	1E-4 - -	1E-3 - -
77	Iridium-188	D, see 182Ir W, see 182Ir Y, see 182Ir	2E+3 - -	5E+3 4E+3 3E+3	2E+6 1E+6 1E+6	6E-9 5E-9 5E-9	3E-5 - -	3E-4 - -
77	Iridium-189	D, see 182Ir W, see 182Ir Y, see 182Ir	5E+3 - -	5E+3 4E+3 4E+3	2E+6 2E+6 1E+6	7E-9 5E-9 5E-9	- 7E-5 -	- 7E-4 -
77	Iridium-190m ²	D, see 182Ir W, see 182Ir Y, see 182Ir	2E+5 - -	2E+5 2E+5 2E+5	8E+5 9E+5 8E+5	3E-7 3E-7 3E-7	2E-3 - -	2E-2 - -
77	Iridium-190	D, see 182Ir W, see 182Ir Y, see 182Ir	1E+3 - -	9E+2 1E+3 9E+2	4E+7 4E+7 4E+7	1E-9 1E-9 1E-9	1E-5 - -	1E-4 - -
77	Iridium-192m	D, see 182Ir W, see 182Ir Y, see 182Ir	3E+3 - -	9E+1 2E+2 2E+1	4E+8 9E+8 6E+9	1E-10 3E-10 2E-11	4E-5 - -	4E-4 - -
77	Iridium-192	D, see 182Ir W, see 182Ir Y, see 182Ir	9E+2 - -	3E+2 4E+2 2E+2	1E+7 2E+7 9E+8	4E-10 6E-10 1E-10	1E-5 - -	1E-4 - -
77	Iridium-194m	D, see 182Ir W, see 182Ir Y, see 182Ir	6E+2 - -	9E+1 2E+2 1E+2	4E+8 7E+8 4E+8	1E-10 2E-10 1E-10	9E-6 - -	9E-5 - -
77	Iridium-194	D, see 182Ir W, see 182Ir Y, see 182Ir	1E+3 - -	3E+3 2E+3 2E+3	1E+6 9E+7 8E+7	4E-9 3E-9 3E-9	1E-5 - -	1E-4 - -
77	Iridium-195m	D, see 182Ir W, see 182Ir Y, see 182Ir	8E+3 - -	2E+4 3E+4 2E+4	1E+5 1E+5 9E+6	3E-8 4E-8 3E-8	1E-4 - -	1E-3 - -
77	Iridium-195	D, see 182Ir W, see 182Ir Y, see 182Ir	1E+4 - -	4E+4 5E+4 4E+4	2E+5 2E+5 2E+5	6E-8 7E-8 6E-8	2E-4 - -	2E-3 - -
78	Platinum-186	D, all compounds	1E+4	4E+4	2E+5	5E-8	2E-4	2E-3
78	Platinum-188	D, all compounds	2E+3	2E+3	7E+7	2E-9	2E-5	2E-4
78	Platinum-189	D, all compounds	1E+4	3E+4	1E+5	4E-8	1E-4	1E-3
78	Platinum-191	D, all compounds	4E+3	8E+3	4E+6	1E-8	5E-5	5E-4

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)		Air (μCi/ml)	Water (μCi/ml)	
78	Platinum-193m	D, all compounds	3E+3 LLI wall (3E+4)	6E+3	3E-6	8E-5	-	-
78	Platinum-193	D, all compounds	4E+4 LLI wall (5E+4)	2E+4	1E-5	3E-8	-	-
78	Platinum-195m	D, all compounds	2E+3 LLI wall (2E+3)	4E+3	2E-6	6E-9	-	-
78	Platinum-197m ²	D, all compounds	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
78	Platinum-197	D, all compounds	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
78	Platinum-199 ²	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
78	Platinum-200	D, all compounds	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
79	Gold-193	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, halides and nitrates	-	2E+4	9E-6	3E-8	-	-
		Y, oxides and hydroxides	-	2E+4	8E-6	3E-8	-	-
79	Gold-194	D, see 193Au	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see 193Au	-	5E+3	2E-6	8E-9	-	-
		Y, see 193Au	-	5E+3	2E-6	7E-9	-	-
79	Gold-195	D, see 193Au	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see 193Au	-	1E+3	6E-7	2E-9	-	-
		Y, see 193Au	-	4E+2	2E-7	6E-10	-	-
79	Gold-196m	D, see 193Au	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see 193Au	-	1E+3	5E-7	2E-9	-	-
		Y, see 193Au	-	1E+3	5E-7	2E-9	-	-
79	Gold-198	D, see 193Au	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see 193Au	-	2E+3	8E-7	3E-9	-	-
		Y, see 193Au	-	2E+3	7E-7	2E-9	-	-
79	Gold-199	D, see 193Au	3E+3 LLI wall (3E+3)	9E+3	4E-6	1E-8	-	-
		W, see 193Au	-	4E+3	2E-6	6E-9	-	-
		Y, see 193Au	-	4E+3	2E-6	5E-9	-	-
79	Gold-200m	D, see 193Au	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see 193Au	-	3E+3	1E-6	4E-9	-	-
		Y, see 193Au	-	2E+4	1E-6	3E-9	-	-
79	Gold-200 ²	D, see 193Au	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see 193Au	-	8E+4	3E-5	1E-7	-	-
		Y, see 193Au	-	7E+4	3E-5	1E-7	-	-
79	Gold-201 ²	D, see 193Au	7E+4 St. wall (9E+4)	2E+5	9E-5	3E-7	-	-
		W, see 193Au	-	2E+5	1E-4	3E-7	-	-
		Y, see 193Au	-	2E+5	9E-5	3E-7	-	-

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
			Oral Ingestion ALI (μCi)	Inhalation		Air ($\mu\text{Ci}/\text{m}^3$)	Water ($\mu\text{Ci}/\text{m}^3$)	
				ALI (μCi)	OAC ($\mu\text{Ci}/\text{m}^3$)			
80	Mercury-193m	Vapor	-	8E+3	4E-6	1E-8	-	-
		Organic D	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		D, sulfates	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, oxides, hydroxides, halides, nitrates, and sulfides	-	8E+3	3E-6	1E-8	-	-
80	Mercury-193	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		D, see 193mHg	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see 193mHg	-	4E+4	2E-5	6E-8	-	-
80	Mercury-194	Vapor	-	3E+1	1E-8	4E-11	-	-
		Organic D	2E+1	3E+1	1E-8	4E-11	2E-7	2E-6
		D, see 193mHg	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
		W, see 193mHg	-	1E+2	5E-8	2E-10	-	-
80	Mercury-195m	Vapor	-	4E+3	2E-6	6E-9	-	-
		Organic D	3E+3	6E+3	3E-6	8E-9	4E-5	4E-4
		D, see 193mHg	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
		W, see 193mHg	-	4E+3	2E-6	5E-9	-	-
80	Mercury-195	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		D, see 193mHg	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
		W, see 193mHg	-	3E+4	1E-5	5E-8	-	-
80	Mercury-197m	Vapor	-	5E+3	2E-6	7E-9	-	-
		Organic D	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		D, see 193mHg	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4
		W, see 193mHg	-	5E+3	2E-6	7E-9	-	-
80	Mercury-197	Vapor	-	8E+3	4E-6	1E-8	-	-
		Organic D	7E+3	1E+4	6E-6	2E-8	9E-5	9E-4
		D, see 193mHg	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see 193mHg	-	9E+3	4E-6	1E-8	-	-
80	Mercury-199m ²	Vapor	-	8E+4	3E-5	1E-7	-	-
		Organic D	6E+4	2E+5	7E-5	2E-7	-	-
		St. wall	(1E+5)	-	-	-	1E-3	1E-2
		D, see 193mHg	6E+4	1E+5	6E-5	2E-7	5E-4	8E-3
		W, see 193mHg	-	2E+5	7E-5	2E-7	-	-
80	Mercury-203	Vapor	-	8E+2	4E-7	1E-9	-	-
		Organic D	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
		D, see 193mHg	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		W, see 193mHg	-	1E+3	5E-7	2E-9	-	-
81	Thallium-194m ²	D, all compounds	5E+4	2E+5	6E-5	2E-7	-	-
		St. wall	(7E+4)	-	-	-	1E-3	1E-2

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{m}^3$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
81	Thallium-194 ²	D, all compounds	3E+5 St. wall (3E+5)	6E+5	2E-4	8E-7	-	-
81	Thallium-195 ²	D, all compounds	6E+4	1E+5	5E-5	2E-7	9E-4	9E-3
81	Thallium-197	D, all compounds	7E+4	1E+5	5E-5	2E-7	1E-3	1E-2
81	Thallium-198m ²	D, all compounds	3E+4	5E+4	2E-5	8E-8	4E-4	4E-3
81	Thallium-198	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
81	Thallium-199	D, all compounds	6E+4	8E+4	4E-5	1E-7	9E-4	9E-3
81	Thallium-200	D, all compounds	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
81	Thallium-201	D, all compounds	2E+4	2E+4	9E-6	3E-8	2E-4	2E-3
81	Thallium-202	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
81	Thallium-204	D, all compounds	2E+3	2E+3	9E-7	3E-9	2E-5	2E-4
82	Lead-195m ²	D, all compounds	6E+4	2E+5	8E-5	3E-7	8E-4	8E-3
82	Lead-198	D, all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
82	Lead-199 ²	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
82	Lead-200	D, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
82	Lead-201	D, all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3
82	Lead-202m	D, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
82	Lead-202	D, all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5
82	Lead-203	D, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
82	Lead-205	D, all compounds	4E+3	1E+3	6E-7	2E-9	5E-5	5E-4
82	Lead-209	D, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
82	Lead-210	D, all compounds	6E-1 Bone surf (1E+0)	2E-1 Bone surf (4E-1)	1E-10	-	-	-
82	Lead-211 ²	D, all compounds	1E+4	6E+2	3E-7	9E-10	2E-4	2E-3
82	Lead-212	D, all compounds	8E+1 Bone surf (1E+2)	3E+1	1E-8	5E-11	-	-
82	Lead-214 ²	D, all compounds	9E+3	8E+2	3E-7	1E-9	1E-4	1E-3
83	Bismuth-200 ²	D, nitrates W, all other compounds	3E+4	8E+4 1E+5	4E-5 4E-5	1E-7 1E-7	4E-4 -	4E-3 -
83	Bismuth-201 ²	D, see 200Bi W, see 200Bi	1E+4 -	3E+4 4E+4	1E-5 2E-5	4E-8 5E-8	2E-4 -	2E-3 -
83	Bismuth-202 ²	D, see 200Bi W, see 200Bi	1E+4 -	4E+4 8E+4	2E-5 3E-5	6E-8 1E-7	2E-4 -	2E-3 -

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
83	Bismuth-203	D, see 200 Bi W, see 200 Bi	2E+3 -	7E+3 6E+3	3E-6 3E-6	9E-9 9E-9	3E-5 -	3E-4 -
83	Bismuth-205	D, see 200 Bi W, see 200 Bi	1E+3 -	3E+3 1E+3	1E-6 5E-7	3E-9 2E-9	2E-5 -	2E-4 -
83	Bismuth-206	D, see 200 Bi W, see 200 Bi	6E+2 -	1E+3 9E+2	6E-7 4E-7	2E-9 1E-9	9E-6 -	9E-5 -
83	Bismuth-207	D, see 200 Bi W, see 200 Bi	1E+3 -	2E+3 4E+2	7E-7 1E-7	2E-9 5E-10	1E-5 -	1E-4 -
83	Bismuth-210m	D, see 200 Bi W, see 200 Bi	4E+1 (6E+1)	5E+0 (6E+0) 7E-1	2E-9 -	- 9E-12 9E-13	- 8E-7 -	- 8E-6 -
83	Bismuth-210	D, see 200 Bi W, see 200 Bi	8E+2 -	2E+2 (4E+2) 3E+1	1E-7 -	- 5E-10 4E-11	1E-5 -	1E-4 -
83	Bismuth-212 ²	D, see 200 Bi W, see 200 Bi	5E+3 -	2E+2 3E+2	1E-7 1E-7	3E-10 4E-10	7E-5 -	7E-4 -
83	Bismuth-213 ²	D, see 200 Bi W, see 200 Bi	7E+3 -	3E+2 4E+2	1E-7 1E-7	4E-10 5E-10	1E-4 -	1E-3 -
83	Bismuth-214 ²	D, see 200 Bi W, see 200 Bi	2E+4 (2E+4)	8E+2 -	3E-7 -	1E-9 -	- 3E-4	- 3E-3
84	Polonium-203 ²	D, all compounds except those given for W W, oxides, hydroxides, and nitrates	3E+4 -	6E+4 9E+4	3E-5 4E-5	9E-8 1E-7	3E-4 -	3E-3 -
84	Polonium-205 ²	D, see 203 Po W, see 203 Po	2E+4 -	4E+4 7E+4	2E-5 3E-5	5E-8 1E-7	3E-4 -	3E-3 -
84	Polonium-207	D, see 203 Po W, see 203 Po	8E+3 -	3E+4 3E+4	1E-5 1E-5	3E-8 4E-8	1E-4 -	1E-3 -
84	Polonium-210	D, see 203 Po W, see 203 Po	3E+0 -	6E-1 6E-1	3E-10 3E-10	9E-13 9E-13	4E-8 -	4E-7 -
85	Astatine-207 ²	D, halides W	6E+3 -	3E+3 2E+3	1E-6 9E-7	4E-9 3E-9	8E-5 -	8E-4 -
85	Astatine-211	D, halides W	1E+2 -	8E+1 5E+1	3E-8 2E-8	1E-10 8E-11	2E-6 -	2E-5 -
86	Radon-220	With daughters removed With daughters present	- -	2E+4 2E+1 (or 12 working level months)	7E-6 9E-9 (or 1.0 working level)	2E-8 3E-11	- -	- -

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci}/\text{Ml}$)
			Oral Ingestion ALI (μCi)	Inhalation		Air ($\mu\text{Ci}/\text{Ml}$)	Water ($\mu\text{Ci}/\text{Ml}$)	
				ALI (μCi)	DAL ($\mu\text{Ci}/\text{Ml}$)			
86	Radon-222	With daughters removed with daughters present	-	$1\text{E}+4$	$4\text{E}+6$	$1\text{E}-8$	-	-
			-	$1\text{E}+2$ (for 4 working level months)	$3\text{E}-8$ (or 0.33 working level)	$1\text{E}-10$	-	-
87	Francium-222 ²	D, all compounds	$2\text{E}+3$	$5\text{E}+2$	$2\text{E}+7$	$6\text{E}+10$	$3\text{E}+5$	$3\text{E}+4$
87	Francium-223 ²	D, all compounds	$6\text{E}+2$	$8\text{E}+2$	$3\text{E}+7$	$1\text{E}+9$	$8\text{E}+6$	$8\text{E}+5$
88	Radium-223	W, all compounds	$5\text{E}+0$ Bone surf ($9\text{E}+0$)	$7\text{E}+1$	$3\text{E}+10$	$9\text{E}+13$	-	-
			-	-	-	$1\text{E}+7$	$1\text{E}+6$	
88	Radium-224	W, all compounds	$8\text{E}+0$ Bone surf ($2\text{E}+1$)	$2\text{E}+0$	$7\text{E}+10$	$2\text{E}+12$	-	-
			-	-	-	$2\text{E}+7$	$2\text{E}+6$	
88	Radium-225	W, all compounds	$8\text{E}+0$ Bone surf ($2\text{E}+1$)	$7\text{E}+1$	$3\text{E}+10$	$9\text{E}+13$	-	-
			-	-	-	$2\text{E}+7$	$2\text{E}+6$	
88	Radium-226	W, all compounds	$2\text{E}+0$ Bone surf ($5\text{E}+0$)	$6\text{E}+1$	$3\text{E}+10$	$9\text{E}+13$	-	-
			-	-	-	$6\text{E}+8$	$6\text{E}+7$	
88	Radium-227 ²	W, all compounds	$2\text{E}+4$ Bone surf ($2\text{E}+4$)	$1\text{E}+4$ Bone surf ($2\text{E}+4$)	$6\text{E}+6$	-	-	-
			-	-	-	$3\text{E}+8$	$3\text{E}+4$	$3\text{E}+3$
88	Radium-228	W, all compounds	$2\text{E}+0$ Bone surf ($4\text{E}+0$)	$1\text{E}+0$	$5\text{E}+10$	$2\text{E}+12$	-	-
			-	-	-	$6\text{E}+8$	$6\text{E}+7$	
89	Actinium-224	D, all compounds except those given for W and Y	$2\text{E}+3$ LLI wall ($2\text{E}+3$)	$3\text{E}+1$ Bone surf ($4\text{E}+1$)	$1\text{E}+8$	-	-	-
		W, halides and nitrates	-	$5\text{E}+1$	$2\text{E}+8$	$7\text{E}+11$	-	-
		Y, oxides and hydroxides	-	$5\text{E}+1$	$2\text{E}+8$	$6\text{E}+11$	-	-
89	Actinium-225	D, see ²²⁴ Ac	$5\text{E}+1$ LLI wall ($5\text{E}+1$)	$3\text{E}+1$ Bone surf ($5\text{E}+1$)	$1\text{E}+10$	-	-	-
		W, see ²²⁴ Ac	-	$6\text{E}+1$	$3\text{E}+10$	$9\text{E}+13$	-	-
		Y, see ²²⁴ Ac	-	$6\text{E}+1$	$3\text{E}+10$	$9\text{E}+13$	-	-
89	Actinium-226	D, see ²²⁴ Ac	$1\text{E}+2$ LLI wall ($1\text{E}+2$)	$3\text{E}+0$ Bone surf ($4\text{E}+0$)	$1\text{E}+9$	-	-	-
		W, see ²²⁴ Ac	-	$5\text{E}+0$	$2\text{E}+9$	$5\text{E}+12$	$2\text{E}+6$	$2\text{E}+5$
		Y, see ²²⁴ Ac	-	$5\text{E}+0$	$2\text{E}+9$	$6\text{E}+12$	-	-
89	Actinium-227	D, see ²²⁴ Ac	$2\text{E}+1$ Bone surf ($4\text{E}+1$)	$4\text{E}+4$ Bone surf ($8\text{E}+4$)	$2\text{E}+13$	-	-	-
		W, see ²²⁴ Ac	-	$2\text{E}+3$ Bone surf ($3\text{E}+3$)	$7\text{E}+13$	$1\text{E}+15$	$5\text{E}+9$	$5\text{E}+8$
		Y, see ²²⁴ Ac	-	$4\text{E}+3$	$2\text{E}+12$	$6\text{E}+15$	-	-

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)	Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
89	Actinium-228	D, see ^{224}Ac	$2\text{E}+3$	$9\text{E}+0$ Bone surf	$4\text{E}+9$	-	$3\text{E}-5$	$3\text{E}-4$
		W, see ^{224}Ac	-	($2\text{E}+1$) $4\text{E}+1$ Bone surf	$2\text{E}+8$	$2\text{E}-11$	-	-
		Y, see ^{224}Ac	-	($6\text{E}+1$) $4\text{E}+1$	$2\text{E}+8$	$8\text{E}-11$ $6\text{E}-11$	-	-
90	Thorium-226 ²	W, all compounds except those given for Y	$5\text{E}+3$ St wall ($5\text{E}+3$)	$2\text{E}+2$	$6\text{E}+8$	$2\text{E}-10$	-	-
		Y, oxides and hydroxides	-	$1\text{E}+2$	$6\text{E}+8$	$2\text{E}-10$	-	-
90	Thorium-227	W, see ^{226}Th	$1\text{E}+2$	$3\text{E}+1$	$1\text{E}-10$	$5\text{E}-13$	$2\text{E}-6$	$2\text{E}-5$
		Y, see ^{226}Th	-	$3\text{E}+1$	$1\text{E}-10$	$5\text{E}-13$	-	-
90	Thorium-228	W, see ^{226}Th	$6\text{E}+0$ Bone surf ($1\text{E}+1$)	$1\text{E}+2$ Bone surf ($2\text{E}+2$)	$4\text{E}-12$	-	-	-
		Y, see ^{226}Th	-	$2\text{E}+2$	$7\text{E}-12$	$3\text{E}-14$ $2\text{E}-14$	$2\text{E}-7$	$2\text{E}-6$
90	Thorium-229	W, see ^{226}Th	$6\text{E}+1$ Bone surf ($1\text{E}+0$)	$9\text{E}+4$ Bone surf ($2\text{E}+3$)	$4\text{E}-13$	-	-	-
		Y, see ^{226}Th	-	$2\text{E}+3$ Bone surf ($3\text{E}+3$)	$1\text{E}-12$	$3\text{E}-15$	$2\text{E}-8$	$2\text{E}-7$
90	Thorium-230	W, see ^{226}Th	$4\text{E}+0$ Bone surf ($9\text{E}+0$)	$6\text{E}+3$ Bone surf ($2\text{E}+2$)	$3\text{E}-12$	-	-	-
		Y, see ^{226}Th	-	$2\text{E}+2$ Bone surf ($2\text{E}+2$)	$6\text{E}-12$	$2\text{E}-14$	$1\text{E}-7$	$1\text{E}-6$
90	Thorium-231	W, see ^{226}Th	$4\text{E}+3$	$6\text{E}+3$	$3\text{E}+6$	$9\text{E}-9$	$5\text{E}-5$	$5\text{E}-4$
		Y, see ^{226}Th	-	$8\text{E}+3$	$3\text{E}+6$	$9\text{E}-9$	-	-
90	Thorium-232	W, see ^{226}Th	$7\text{E}-1$ Bone surf ($2\text{E}+0$)	$1\text{E}+3$ Bone surf ($3\text{E}+3$)	$5\text{E}-13$	-	-	-
		Y, see ^{226}Th	-	$3\text{E}+3$ Bone surf ($4\text{E}+3$)	$1\text{E}-12$	$4\text{E}-15$	$3\text{E}-8$	$3\text{E}-7$
90	Thorium-234	W, see ^{226}Th	$3\text{E}+2$ LLI wall ($4\text{E}+2$)	$2\text{E}+2$	$8\text{E}+8$	$3\text{E}+10$	-	-
		Y, see ^{226}Th	-	$2\text{E}+2$	$6\text{E}+8$	$2\text{E}-10$	$5\text{E}-6$	$5\text{E}-5$
91	Protactinium-227 ²	W, all compounds except those given for Y	$4\text{E}+3$	$1\text{E}+2$	$5\text{E}+8$	$2\text{E}-10$	$5\text{E}-5$	$5\text{E}-4$
		Y, oxides and hydroxides	-	$1\text{E}+2$	$4\text{E}+8$	$1\text{E}-10$	-	-
91	Protactinium-228	W, see ^{227}Pa	$1\text{E}+3$	$1\text{E}+1$ Bone surf ($2\text{E}+1$)	$5\text{E}+9$	-	$2\text{E}-5$	$2\text{E}-4$
		Y, see ^{226}Pa	-	$1\text{E}+1$	$5\text{E}+9$	$3\text{E}-11$ $2\text{E}-11$	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Release to Sewers
			Col. 1 Oral Ingestion ALI (μ Ci)	Inhalation		Col. 1 Air (μ Ci/ml)	Col. 2 Water (μ Ci/ml)	Monthly Average Concentration (μ Ci/ml)
				Col. 2 ALI (μ Ci)	Col. 3 DAC (μ Ci/ml)			
91	Protactinium-230	W, see 227Pa	6E+2 Bone surf (9E+2)	5E+0	2E-9	7E-12	-	-
		Y, see 227Pa	-	4E+0	1E-9	5E-12	1E-5	1E-4
91	Protactinium-231	W, see 227Pa	2E-1 Bone surf (5E-1)	2E-3 Bone surf (4E-3)	6E-13	-	-	-
		Y, see 226Pa	-	4E-3 Bone surf (6E-3)	2E-12	6E-15	6E-9	6E-8
91	Protactinium-232	W, see 227Pa	1E+3	2E+1 Bone surf (6E+1)	9E-9	-	2E-5	2E-4
		Y, see 227Pa	-	6E+1 Bone surf (7E+1)	2E-8	8E-11	-	-
91	Protactinium-233	W, see 227Pa	1E+3 LLI wall (2E+3)	7E+2	3E-7	1E-9	-	-
		Y, see 227Pa	-	6E+2	2E-7	8E-10	2E-5	2E-4
91	Protactinium-234	W, see 227Pa	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		Y, see 227Pa	-	7E+3	3E-6	9E-9	-	-
92	Uranium-230	D, UF ₆ , UO ₂ F ₂ , UO ₂ (NO ₃) ₂	4E+0 Bone surf (6E+0)	4E-1 Bone surf (6E-1)	2E-10	-	-	-
		W, UO ₃ , UF ₆ , UCl ₄	-	4E-1	1E-10	8E-13	4E-8	8E-7
		Y, UO ₂ , U ₃ O ₈	-	3E-1	1E-10	5E-13	-	-
92	Uranium-231	D, see 230U	5E+3 LLI wall (4E+3)	8E+3	3E-6	1E-8	-	-
		W, see 230U	-	6E+3	2E-6	8E-9	6E-5	6E-4
		Y, see 230U	-	5E+3	2E-6	6E-9	-	-
92	Uranium-232	D, see 230U	2E+0 Bone surf (4E+0)	2E-1 Bone surf (4E-1)	9E-11	-	-	-
		W, see 230U	-	4E-1	2E-10	6E-13	6E-8	6E-7
		Y, see 230U	-	8E-3	3E-12	5E-13	-	-
92	Uranium-233	D, see 230U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	-	-	-
		W, see 230U	-	7E-1	3E-10	3E-12	3E-7	3E-6
		Y, see 230U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-234 ³	D, see 230U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	-	-	-
		W, see 230U	-	7E-1	3E-10	3E-12	3E-7	3E-6
		Y, see 230U	-	4E-2	2E-11	5E-14	-	-

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Ingestion ALI (μCi)	Inhalation		Air ($\mu\text{Ci}/\text{ml}$)	Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2	Col. 3			
				ALI (μCi)	DAL ($\mu\text{Ci}/\text{ml}$)			
92	Uranium-235 ³	D, see 230U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	6E-10	-	-	-
		W, see 230U	-	8E-1	3E-10	3E-12	3E-7	3E-6
		Y, see 230U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-236	D, see 230U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	-	-	-
		W, see 230U	-	8E-1	3E-10	3E-12	3E-7	3E-6
		Y, see 230U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-237	D, see 230U	2E+3 LLI wall (2E+3)	3E+3	1E-6	4E-9	-	-
		W, see 230U	-	2E+3	7E-7	2E-9	3E-5	3E-4
		Y, see 230U	-	2E+3	6E-7	2E-9	-	-
92	Uranium-238 ³	D, see 230U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	6E-10	-	-	-
		W, see 230U	-	8E-1	3E-10	3E-12	3E-7	3E-6
		Y, see 230U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-239 ²	D, see 230U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		W, see 230U	-	2E+5	7E-5	2E-7	-	-
		Y, see 230U	-	2E+5	6E-5	2E-7	-	-
92	Uranium-240	D, see 230U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see 230U	-	3E+3	1E-6	4E-9	-	-
		Y, see 230U	-	2E+3	1E-6	3E-9	-	-
92	Uranium-natural ³	D, see 230U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	-	-	-
		W, see 230U	-	8E-1	3E-10	3E-12	3E-7	3E-6
		Y, see 230U	-	5E-2	2E-11	9E-14	-	-
93	Neptunium-232 ²	W, all compounds	1E+5	2E+3 Bone surf (5E+2)	7E-7	-	2E-3	2E-2
			-	-	-	6E-9	-	-
93	Neptunium-233 ²	W, all compounds	8E+5	3E+6	1E-3	4E-6	1E-2	1E-1
93	Neptunium-234	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
93	Neptunium-235	W, all compounds	2E+4 LLI wall (2E+4)	8E+2 Bone surf (1E+3)	3E-7	-	-	-
			-	-	-	2E-9	3E-4	3E-3
93	Neptunium-236 (1.15E+5 y)	W, all compounds	3E+0 Bone surf (6E+0)	2E-2 Bone surf (5E-2)	9E-12	-	-	-
			-	-	-	8E-14	9E-8	9E-7
93	Neptunium-236m (22.5 h)	W, all compounds	3E+3 Bone surf (4E+3)	3E+1 Bone surf (7E+1)	1E-8	-	-	-
			-	-	-	1E-10	5E-5	5E-4
93	Neptunium-237	W, all compounds	5E-1 Bone surf (1E+0)	4E-3 Bone surf (1E-2)	2E-12	-	-	-
			-	-	-	1E-14	2E-8	2E-7

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
93	Neptunium-238	W, all compounds	1E+3	6E+1 Bone surf (2E+2)	3E-8	-	2E-5	2E-4
93	Neptunium-239	W, all compounds	2E+3 LLI wall (2E+3)	2E+3	9E-7	3E-9	-	-
93	Neptunium-240 ²	W, all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
94	Plutonium-234	W, all compounds except PuO_2 Y, PuO_2	8E+3	2E+2 2E+2	9E-8 8E-8	3E-10 3E-10	1E-4	1E-3
94	Plutonium-235 ²	W, see ^{234}Pu Y, see ^{234}Pu	9E+5	3E+6 3E+6	1E-3 1E-3	4E-6 3E-6	1E-2	1E-1
94	Plutonium-236	W, see ^{234}Pu Y, see ^{234}Pu	2E+0 Bone surf (4E+0)	2E-2 Bone surf (4E-2) 4E-2	8E-12	-	-	-
94	Plutonium-237	W, see ^{234}Pu Y, see ^{234}Pu	1E+4	3E+3 3E+3	1E-6 1E-6	5E-9 4E-9	2E-4	2E-3
94	Plutonium-238	W, see ^{234}Pu Y, see ^{234}Pu	9E-1 Bone surf (2E+0)	7E-3 Bone surf (1E-2) 2E-2	3E-12	-	-	-
94	Plutonium-239	W, see ^{234}Pu Y, see ^{234}Pu	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2) 2E-2 Bone surf (2E-2)	3E-12	-	-	-
94	Plutonium-240	W, see ^{234}Pu Y, see ^{234}Pu	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2) 2E-2 Bone surf (2E-2)	3E-12	-	-	-
94	Plutonium-241	W, see ^{234}Pu Y, see ^{234}Pu	4E+1 Bone surf (7E+1)	3E-1 Bone surf (6E-1) 8E-1 Bone surf (1E+0)	1E-10	-	-	-

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
94	Plutonium-242	W, see ^{234}Pu	8E-1 Bone surf (1E+0)	7E-3 Bone surf (1E-2)	3E-12	-	-	-
		Y, see ^{234}Pu	-	2E-2 Bone surf (2E-2)	7E-12	2E-14	2E-8	2E-7
94	Plutonium-243	W, see ^{234}Pu	2E+4	4E+4	2E-5	5E-8	2E-4	2E-3
		Y, see ^{234}Pu	-	4E+4	2E-5	5E-8	-	-
94	Plutonium-244	W, see ^{234}Pu	8E-1 Bone surf (2E+0)	7E-3 Bone surf (1E-2)	3E-12	-	-	-
		Y, see ^{234}Pu	-	2E-2 Bone surf (2E-2)	7E-12	2E-14	2E-8	2E-7
94	Plutonium-245	W, see ^{234}Pu	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
		Y, see ^{234}Pu	-	4E+3	2E-6	6E-9	-	-
94	Plutonium-246	W, see ^{234}Pu	4E+2 LLI wall (4E+2)	3E+2	1E-7	4E-10	-	-
		Y, see ^{234}Pu	-	3E+2	1E-7	4E-10	6E-6	6E-5
95	Americium-237 ²	W, all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2
95	Americium-238 ²	W, all compounds	4E+4	3E+3	1E-6	-	5E-4	5E-3
			-	Bone surf (6E+3)	-	9E-9	-	-
95	Americium-239	W, all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
95	Americium-240	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
95	Americium-241	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	-	-	-
95	Americium-242a	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	-	-	-
			-	2E-14	2E-8	2E-7	-	-
95	Americium-242	W, all compounds	4E+3	8E+1 Bone surf (9E+1)	4E-8	-	5E-5	5E-4
			-	1E-10	-	-	-	-
95	Americium-243	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	-	-	-
95	Americium-244a ²	W, all compounds	6E+4 St. wall (8E+4)	4E+3 Bone surf (7E+3)	2E-6	-	-	-
			-	1E-8	1E-3	1E-2	-	-
95	Americium-244	W, all compounds	3E+3	2E+2 Bone surf (3E+2)	8E-8	-	4E-5	4E-4
95	Americium-245	W, all compounds	-	4E-10	-	-	-	-
			3E+4	8E+4	3E-5	1E-7	4E-4	4E-3

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation		Air (μCi/ml)	Water (μCi/ml)	
				ALI (μCi)	DAC (μCi/ml)			
95	Americium-245 ²	W, all compounds	5E+4 St. wall (5E+4)	2E+5	8E-5	3E-7	-	-
95	Americium-245 ²	W, all compounds	3E+4	1E+5	4E-5	1E-7	8E-4	8E-3
96	Curium-238	W, all compounds	2E+4	1E+3	5E-7	2E-9	2E-4	2E-3
96	Curium-240	W, all compounds	6E+1 Bone surf (8E+1)	6E+1 Bone surf (6E+1)	2E-10	-	-	-
96	Curium-241	W, all compounds	1E+3	3E+1 Bone surf (4E+1)	1E-8	-	2E-5	2E-4
96	Curium-242	W, all compounds	3E+1 Bone surf (5E+1)	3E+1 Bone surf (3E+1)	1E-10	-	-	-
96	Curium-243	W, all compounds	1E+0 Bone surf (2E+0)	9E-3 Bone surf (2E-2)	4E-12	-	-	-
96	Curium-244	W, all compounds	1E+0 Bone surf (3E+0)	1E-2 Bone surf (2E-2)	5E-12	-	-	-
96	Curium-245	W, all compounds	7E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	-	-	-
96	Curium-246	W, all compounds	7E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	-	-	-
96	Curium-247	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	-	-	-
96	Curium-248	W, all compounds	2E-1 Bone surf (4E-1)	2E-3 Bone surf (3E-3)	7E-13	-	-	-
96	Curium-249 ²	W, all compounds	5E+4	2E+4 Bone surf (3E+4)	7E-6	-	7E-4	7E-3
96	Curium-250	W, all compounds	4E-2 Bone surf (6E-2)	3E-4 Bone surf (5E-4)	1E-13	-	-	-
97	Berkelium-245	W, all compounds	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
97	Berkelium-246	W, all compounds	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
97	Berkelium-247	W, all compounds	5E-1 Bone surf (1E+0)	4E-3 Bone surf (9E-3)	2E-12	-	-	-
97	Berkelium-249	W, all compounds	2E+2 Bone surf (5E+2)	2E+0 Bone surf (4E+0)	7E-10	-	-	-

PART 20 STANDARDS FOR PROTECTION AGAINST RADIATION

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAI (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
97	Berkelium-250	W, all compounds	9E+3	3E+2 Bone surf (7E+2)	1E-7	-	1E-4	1E-3
98	Californium-244 ²	W, all compounds except those given for Y	3E+4 St. wall (3E+4)	6E+2	2E-7	8E-10	-	-
		Y, oxides and hydroxides	-	6E+2	2E-7	8E-10	-	-
98	Californium-246	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	4E+2	9E+0 9E+0	4E-9	1E-11 1E-11	5E-6	5E-5
98	Californium-248	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	8E+0 Bone surf (2E+1)	6E+2 Bone surf (1E-1)	3E-11	-	-	-
		Y, see ²⁴⁴ Cf	-	1E-1	4E-11	1E-13	2E-7	2E-6
98	Californium-249	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	5E-1 Bone surf (1E+0)	4E-3 Bone surf (9E-3)	2E-12	-	-	-
		Y, see ²⁴⁴ Cf	-	1E-2 Bone surf (1E-2)	4E-12	1E-14	2E-8	2E-7
98	Californium-250	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	1E+0 Bone surf (2E+0)	9E-3 Bone surf (2E-2)	4E-12	-	-	-
		Y, see ²⁴⁴ Cf	-	3E-2	1E-11	3E-14 4E-14	3E-8	3E-7
98	Californium-251	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	5E-1 Bone surf (1E+0)	4E-3 Bone surf (9E-3)	2E-12	-	-	-
		Y, see ²⁴⁴ Cf	-	1E-2 Bone surf (1E-2)	4E-12	1E-14	2E-8	2E-7
98	Californium-252	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	2E+0 Bone surf (5E+0)	2E-2 Bone surf (4E-2)	8E-12	-	-	-
		Y, see ²⁴⁴ Cf	-	3E-2	1E-11	5E-14 5E-14	7E-8	7E-7
98	Californium-253	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	2E+2 Bone surf (4E+2)	2E+0	8E-10	3E-12	-	-
		Y, see ²⁴⁴ Cf	-	2E+0	7E-10	2E-12	5E-6	5E-5
98	Californium-254	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	2E+0	2E-2 2E-2	9E-12 7E-12	3E-14 2E-14	3E-8	3E-7
99	Einsteinium-250	W, all compounds	4E+4	5E+2 Bone surf (1E+3)	2E-7	-	6E-4	6E-3
		Y, see ²⁴⁴ Cf	-	1E-3	-	2E-9	-	-
99	Einsteinium-251	W, all compounds	7E+3	9E+2 Bone surf (1E+3)	4E-7	-	1E-4	1E-3
		Y, see ²⁴⁴ Cf	-	1E-3	-	2E-9	-	-
99	Einsteinium-253	W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5

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			Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col. 3	Col. 1 Air ($\mu\text{Ci}/\text{m}^3$)	Col. 2 Water ($\mu\text{Ci}/\text{m}^3$)	Monthly Average Concentration ($\mu\text{Ci}/\text{m}^3$)
			Oral Ingestion ALI (μCi)	Inhalation				
				ALI (μCi)	DAC ($\mu\text{Ci}/\text{m}^3$)			
99	Einsteinium-254	W, all compounds	3E+2 LLI wall (3E+2)	1E+1	4E-9	1E-11	-	-
99	Einsteinium-254	W, all compounds	8E+0 Bone surf (2E+1)	7E-2 Bone surf (1E-1)	3E-11	-	4E-6	4E-5
100	Fermium-252	W, all compounds	5E+2	1E+1	5E-9	2E-11	6E-6	6E-5
100	Fermium-253	W, all compounds	1E+3	1E+1	4E-9	1E-11	1E-5	1E-4
100	Fermium-254	W, all compounds	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
100	Fermium-255	W, all compounds	5E+2	2E+1	9E-9	3E-11	7E-6	7E-5
100	Fermium-257	W, all compounds	2E+1 Bone surf (4E+1)	2E-1 Bone surf (2E-1)	7E-11	-	-	-
101	Mendelevium-257	W, all compounds	7E+3	8E+1 Bone surf (9E+1)	4E-8	-	1E-4	1E-3
101	Mendelevium-258	W, all compounds	3E+1 Bone surf (5E+1)	2E-1 Bone surf (3E-1)	1E-10	-	-	-
-	Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 7 hours		Submersion ¹	2E+2	1E-7	1E-9	-	-
-	Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours		-	2E-1	1E-10	1E-12	1E-8	1E-7
-	Any single radionuclide not listed above that decays by alpha emission or spontaneous fission, or any mixture for which either the identity or the concentration of any radionuclide in the mixture is not known		-	4E-4	2E-13	1E-15	2E-9	2E-8

FOOTNOTES:

¹ "Submersion" means that values given are for submersion in a hemispherical semi-infinite cloud of airborne material.

² These radionuclides have radiological half-lives of less than 2 hours. The total effective dose equivalent received during operations with these radionuclides might include a significant contribution from external exposure. The DAC values for all radionuclides, other than those designated Class "Submersion," are based upon the committed effective dose equivalent due to the intake of the radionuclide into the body and do NOT include potentially significant contributions to dose equivalent from external exposures. The licensee may substitute $1E-7$ $\mu\text{Ci}/\text{ml}$ for the listed DAC to account for the submersion dose prospectively, but should use individual monitoring devices or other radiation measuring instruments that measure external exposure to demonstrate compliance with the limits. (See § 20.1203.)

³ For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor (see § 20.1201e). If the percent by weight (enrichment) of U-235 is not greater than 5, the concentration value for a 40-hour workweek is 0.2 milligrams uranium per cubic meter of air average. For any enrichment, the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed $8E-3$ (SA) $\mu\text{Ci}\cdot\text{hr}/\text{ml}$, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is $6.7E-7$ curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, shall be:

$$SA = 3.6E-7 \text{ curies/gram U} \quad \text{U-depleted}$$

$$SA = [0.4 + 0.38 (\text{enrichment}) + 0.0034 (\text{enrichment})^2] E-6, \quad \text{enrichment} \geq 0.72$$

where enrichment is the percentage by weight of U-235, expressed as percent.

NOTE:

1. If the identity of each radionuclide in a mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture shall be the most restrictive DAC of any radionuclide in the mixture.
2. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in this appendix are not present in the mixture, the inhalation ALI, DAC, and effluent and sewage concentrations for the mixture are the lowest values specified in this appendix for any radionuclide that is not known to be absent from the mixture; or

Radionuclide	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
	Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)	Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
If it is known that Ac-227-D and Cm-250-W are not present	-	$7E-4$	$3E-13$	-	-	-
If, in addition, it is known that Ac-227-W, Y, Th-229-W, Y, Th-230-W, Th-232-W, Y, Pa-231-W, Y, Np-237-W, Pu-239-W, Pu-240-W, Pu-242-W, Am-241-W, Cm-242m-W, Am-243-W, Cm-245-W, Cm-246-W, Cm-247-W, Cm-248-W, Bk-247-W, Cf-249-W, and Cf-251-W are not present	-	$7E-3$	$3E-12$	-	-	-
If, in addition, it is known that Sm-146-W, Sm-147-W, Gd-148-D, W, Gd-152-D, W, Th-228-W, Y, Th-230-Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, Np-236-W, Pu-236-W, Y, Pu-238-W, Y, Pu-239-Y, Pu-240-Y, Pu-242-Y, Pu-244-W, Y, Cm-243-W, Cm-244-W, Cf-248-W, Cf-249-Y, Cf-250-W, Y, Cf-251-Y, Cf-252-W, Y, and Cf-254-W, Y are not present	-	$7E-2$	$3E-11$	-	-	-
If, in addition, it is known that Pb-210-D, Bi-210m-W, Po-210-D, W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D, W, Y, Th-227-W, Y, U-230-D, W, Y, U-232-D, W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-Y, Es-254-W, Fm-257-W, and Md-258-W are not present	-	$7E-1$	$3E-10$	-	-	-

Radionuclide	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
	Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)		Air ($\mu\text{Ci}/\text{m}^3$)	Water ($\mu\text{Ci}/\text{ml}$)	
If, in addition, it is known that Si-32-Y, Ti-44-Y, Fe-60-D, Sr-90-Y, Zr-93-D, Cd-113m-D, Cd-113-D, In-115-D, La-138-D, Lu-176-W, Hf-178m-D, W, Hf-182-D, W, Bi-210m-D, Ra-224-W, Ra-228-W, Ac-226-D, W, Y, Pa-230-W, Y, U-233-D, W, U-234-D, W, U-235-D, W, U-236-D, W, U-238-D, W, Pu-241-Y, Bk-249-W, Cf-253-W, Y, and Es-253-W are not present		7E+0	3E-9			
If it is known that Ac-227-D, W, Y, Th-229-W, Y, Th-232-W, Y, Pa-231-W, Y, Cm-248-W, and Cm-250-W are not present				1E-14		
If, in addition, it is known that Sm-146-W, Gd-148-D, W, Gd-152-D, Th-228-W, Y, Th-230-W, Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, U-Nat-Y, Np-236-W, Np-237-W, Pu-236-W, Y, Pu-238-W, Y, Pu-239-W, Y, Pu-240-W, Y, Pu-242-W, Y, Pu-244-W, Y, Am-241-W, Am-242m-W, Am-243-W, Cm-243-W, Cm-244-W, Cm-245-W, Cm-246-W, Cm-247-W, Bk-247-W, Cf-249-W, Y, Cf-250-W, Y, Cf-251-W, Y, Cf-252-W, Y, and Cf-254-W, Y are not present				1E-13		
If, in addition, it is known that Sm-147-W, Gd-152-W, Pb-210-D, Bi-210m-W, Po-210-D, W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D, W, Y, Th-227-W, Y, U-230-D, W, Y, U-232-D, W, U-Nat-W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-W, Y, Es-254-W, Fm-257-W, and Md-258-W are not present				1E-12		
If, in addition it is known that Fe-60, Sr-90, Cd-113m, Cd-113, In-115, I-129, Cs-134, Sm-145, Sm-147, Gd-148, Gd-152, Hg-194 (organic), Bi-210m, Ra-223, Ra-224, Ra-225, Ac-225, Th-228, Th-230, U-233, U-234, U-235, U-236, U-238, U-Nat, Cm-242, Cf-248, Es-254, Fm-257, and Md-258 are not present					1E-6	1E-5

3. If a mixture of radionuclides consists of uranium and its daughters in one dust (10 μm AMAD particle distribution assumed) prior to chemical separation of the uranium from the ore, the following values may be used for the DAC of the mixture: 6E-11 μCi of gross alpha activity from uranium-238, uranium-234, thorium-230, and radium-226 per milliliter of air; 3E-11 μCi of natural uranium per milliliter of air; or 45 micrograms of natural uranium per cubic meter of air.
4. If the identity and concentration of each radionuclide in a mixture are known, the limiting values should be derived as follows: determine, for each radionuclide in the mixture, the ratio between the concentration present in the mixture and the concentration otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all of 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 DACs are DAC_A , DAC_B , and DAC_C , respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{\text{DAC}_A} + \frac{C_B}{\text{DAC}_B} + \frac{C_C}{\text{DAC}_C} \leq 1$$

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING

Radionuclide	Quantity (μ Ci)
Hydrogen-3	1,000
Beryllium-7	1,000
Beryllium-10	1
Carbon-11	1,000
Carbon-14	1,000
Fluorine-18	1,000
Sodium-22	10
Sodium-24	100
Magnesium-28	100
Aluminum-26	10
Silicon-31	1,000
Silicon-32	1
Phosphorus-32	10
Phosphorus-33	100
Sulfur-35	100
Chlorine-36	10
Chlorine-38	1,000
Chlorine-39	1,000
Argon-39	1,000
Argon-41	1,000
Potassium-40	100
Potassium-42	1,000
Potassium-43	1,000
Potassium-44	1,000
Potassium-45	1,000
Calcium-41	100
Calcium-45	100
Calcium-47	100
Scandium-43	1,000
Scandium-44m	100
Scandium-44	100
Scandium-46	10
Scandium-47	100
Scandium-48	100
Scandium-49	1,000
Titanium-44	1
Titanium-45	1,000
Vanadium-47	1,000
Vanadium-48	100
Vanadium-49	1,000
Chromium-48	1,000
Chromium-49	1,000
Chromium-51	1,000
Manganese-51	1,000
Manganese-52m	1,000
Manganese-52	100
Manganese-53	1,000
Manganese-54	100
Manganese-56	1,000
Iron-52	100
Iron-55	100
Iron-59	10
Iron-60	1
Cobalt-55	100
Cobalt-56	10
Cobalt-57	100
Cobalt-58m	1,000
Cobalt-58	100
Cobalt-60m	1,000
Cobalt-60	1
Cobalt-61	1,000
Cobalt-62m	1,000
Nickel-56	100
Nickel-57	100
Nickel-59	100
Nickel-63	100
Nickel-65	1,000
Nickel-66	10
Copper-60	1,000
Copper-61	1,000
Copper-64	1,000

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING—Continued

Radionuclide	Quantity (μ Ci)
Copper-67	1,000
Zinc-62	100
Zinc-63	1,000
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zinc-71m	1,000
Zinc-72	100
Gallium-65	1,000
Gallium-66	100
Gallium-67	1,000
Gallium-68	1,000
Gallium-70	1,000
Gallium-72	100
Gallium-73	1,000
Germanium-66	1,000
Germanium-67	1,000
Germanium-68	10
Germanium-69	1,000
Germanium-71	1,000
Germanium-75	1,000
Germanium-77	1,000
Germanium-78	1,000
Arsenic-69	1,000
Arsenic-70	1,000
Arsenic-71	100
Arsenic-72	100
Arsenic-73	100
Arsenic-74	100
Arsenic-76	100
Arsenic-77	100
Arsenic-78	1,000
Selenium-70	1,000
Selenium-73m	1,000
Selenium-73	100
Selenium-75	100
Selenium-79	100
Selenium-81m	1,000
Selenium-81	1,000
Selenium-83	1,000
Bromine-74m	1,000
Bromine-74	1,000
Bromine-75	1,000
Bromine-76	100
Bromine-77	1,000
Bromine-80m	1,000
Bromine-80	1,000
Bromine-82	100
Bromine-83	1,000
Bromine-84	1,000
Krypton-74	1,000
Krypton-76	1,000
Krypton-77	1,000
Krypton-79	1,000
Krypton-81	1,000
Krypton-83m	1,000
Krypton-85m	1,000
Krypton-85	1,000
Krypton-87	1,000
Krypton-88	1,000
Rubidium-79	1,000
Rubidium-81m	1,000
Rubidium-81	1,000
Rubidium-82m	1,000
Rubidium-83	100
Rubidium-84	100
Rubidium-86	100
Rubidium-87	100
Rubidium-88	1,000
Rubidium-89	1,000
Strontium-80	100
Strontium-81	1,000
Strontium-83	100
Strontium-85m	1,000
Strontium-85	100
Strontium-87m	1,000

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING—Continued

Radionuclide	Quantity (μ Ci)
Strontium-89	10
Strontium-90	0.1
Strontium-91	100
Strontium-92	100
Yttrium-86m	1,000
Yttrium-86	100
Yttrium-87	100
Yttrium-88	10
Yttrium-90m	1,000
Yttrium-90	10
Yttrium-91m	1,000
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Yttrium-94	1,000
Yttrium-95	1,000
Zirconium-86	100
Zirconium-88	10
Zirconium-89	100
Zirconium-93	1
Zirconium-95	10
Zirconium-97	100
Niobium-88	1,000
Niobium-89a (66 min)	1,000
Niobium-89 (122 min)	1,000
Niobium-90	100
Niobium-93m	10
Niobium-94	1
Niobium-95m	100
Niobium-95	100
Niobium-96	100
Niobium-97	1,000
Niobium-98	1,000
Molybdenum-90	100
Molybdenum-93m	100
Molybdenum-93	10
Molybdenum-99	100
Molybdenum-101	1,000
Technetium-93m	1,000
Technetium-93	1,000
Technetium-94m	1,000
Technetium-94	1,000
Technetium-96m	1,000
Technetium-96	100
Technetium-97m	100
Technetium-97	1,000
Technetium-98	10
Technetium-99m	1,000
Technetium-99	100
Technetium-101	1,000
Technetium-104	1,000
Ruthenium-94	1,000
Ruthenium-97	1,000
Ruthenium-103	100
Ruthenium-105	1,000
Ruthenium-106	1
Rhodium-99m	1,000
Rhodium-99	100
Rhodium-100	100
Rhodium-101m	1,000
Rhodium-101	10
Rhodium-102m	10
Rhodium-102	10
Rhodium-103m	1,000
Rhodium-105	100
Rhodium-106m	1,000
Rhodium-107	1,000
Palladium-100	100
Palladium-101	1,000
Palladium-103	100
Palladium-107	10
Palladium-109	100
Silver-102	1,000
Silver-103	1,000
Silver-104m	1,000
Silver-104	1,000

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING--Continued

Radionuclide	Quantity (μ Ci)
Silver-105	100
Silver-106m	100
Silver-106	1,000
Silver-108m	1
Silver-110m	10
Silver-111	100
Silver-112	100
Silver-115	1,000
Cadmium-104	1,000
Cadmium-107	1,000
Cadmium-109	1
Cadmium-113m	0.1
Cadmium-113	100
Cadmium-115m	10
Cadmium-115	100
Cadmium-117m	1,000
Cadmium-117	1,000
Indium-109	1,000
Indium-110 (69.1min.)	1,000
Indium-110 (4.9h)	1,000
Indium-111	100
Indium-112	1,000
Indium-113m	1,000
Indium-114m	10
Indium-115m	1,000
Indium-115	100
Indium-116m	1,000
Indium-117m	1,000
Indium-117	1,000
Indium-119m	1,000
Tin-110	100
Tin-111	1,000
Tin-113	100
Tin-117m	100
Tin-119m	100
Tin-121m	100
Tin-121	1,000
Tin-123m	1,000
Tin-123	10
Tin-125	10
Tin-126	10
Tin-127	1,000
Tin-128	1,000
Antimony-115	1,000
Antimony-116m	1,000
Antimony-116	1,000
Antimony-117	1,000
Antimony-118m	1,000
Antimony-119	1,000
Antimony-120 (18min.)	1,000
Antimony-120 (5.78d)	100
Antimony-122	100
Antimony-124m	1,000
Antimony-124	10
Antimony-125	100
Antimony-126m	1,000
Antimony-126	100
Antimony-127	100
Antimony-128 (10.4min.)	1,000
Antimony-128 (9.01h)	100
Antimony-129	100
Antimony-130	1,000
Antimony-131	1,000
Tellurium-116	1,000
Tellurium-121m	10
Tellurium-121	100
Tellurium-123m	10
Tellurium-123	100
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	1,000
Tellurium-129m	10
Tellurium-129	1,000
Tellurium-131m	10
Tellurium-131	100

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING--Continued

Radionuclide	Quantity (μ Ci)
Tellurium-132	10
Tellurium-133m	100
Tellurium-133	1,000
Tellurium-134	1,000
Iodine-120m	1,000
Iodine-120	100
Iodine-121	1,000
Iodine-123	100
Iodine-124	10
Iodine-125	1
Iodine-126	1
Iodine-128	1,000
Iodine-129	1
Iodine-130	10
Iodine-131	1
Iodine-132m	100
Iodine-132	100
Iodine-133	10
Iodine-134	1,000
Iodine-135	100
Xenon-120	1,000
Xenon-121	1,000
Xenon-122	1,000
Xenon-123	1,000
Xenon-125	1,000
Xenon-127	1,000
Xenon-129m	1,000
Xenon-131m	1,000
Xenon-133m	1,000
Xenon-133	1,000
Xenon-135m	1,000
Xenon-135	1,000
Xenon-138	1,000
Cesium-125	1,000
Cesium-127	1,000
Cesium-129	1,000
Cesium-130	1,000
Cesium-131	1,000
Cesium-132	100
Cesium-134m	1,000
Cesium-134	10
Cesium-135m	1,000
Cesium-135	100
Cesium-136	10
Cesium-137	10
Cesium-138	1,000
Barium-126	1,000
Barium-128	100
Barium-131m	1,000
Barium-131	100
Barium-133m	100
Barium-133	100
Barium-135m	100
Barium-139	1,000
Barium-140	100
Barium-141	1,000
Barium-142	1,000
Lanthanum-131	1,000
Lanthanum-132	100
Lanthanum-135	1,000
Lanthanum-137	10
Lanthanum-138	100
Lanthanum-140	100
Lanthanum-141	100
Lanthanum-142	1,000
Lanthanum-143	1,000
Cerium-134	100
Cerium-135	100
Cerium-137m	100
Cerium-137	1,000
Cerium-139	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Praseodymium-136	1,000
Praseodymium-137	1,000

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING--Continued

Radionuclide	Quantity (μ Ci)
Praseodymium-138m	1,000
Praseodymium-139	1,000
Praseodymium-142m	1,000
Praseodymium-142	100
Praseodymium-143	100
Praseodymium-144	1,000
Praseodymium-145	100
Praseodymium-147	1,000
Neodymium-136	1,000
Neodymium-138	100
Neodymium-139m	1,000
Neodymium-139	1,000
Neodymium-141	1,000
Neodymium-147	100
Neodymium-149	1,000
Neodymium-151	1,000
Promethium-141	1,000
Promethium-143	100
Promethium-144	10
Promethium-145	10
Promethium-146	1
Promethium-147	10
Promethium-148m	10
Promethium-148	10
Promethium-149	100
Promethium-150	1,000
Promethium-151	100
Samarium-141m	1,000
Samarium-141	1,000
Samarium-142	1,000
Samarium-145	100
Samarium-146	1
Samarium-147	100
Samarium-151	10
Samarium-153	100
Samarium-155	1,000
Samarium-156	1,000
Europium-145	100
Europium-146	100
Europium-147	100
Europium-148	10
Europium-149	100
Europium-150 (12.62h)	100
Europium-150 (34.2y)	1
Europium-152m	100
Europium-152	1
Europium-154	1
Europium-155	10
Europium-156	100
Europium-157	100
Europium-158	1,000
Gadolinium-145	1,000
Gadolinium-146	10
Gadolinium-147	100
Gadolinium-148	0.001
Gadolinium-149	100
Gadolinium-151	10
Gadolinium-152	100
Gadolinium-153	10
Gadolinium-159	100
Terbium-147	1,000
Terbium-149	100
Terbium-150	1,000
Terbium-151	100
Terbium-153	1,000
Terbium-154	100
Terbium-155	1,000
Terbium-156m (5.0h)	1,000
Terbium-156m (24.4h)	1,000
Terbium-156	100
Terbium-157	10
Terbium-158	1
Terbium-160	10
Terbium-161	100
Dysprosium-155	1,000
Dysprosium-157	1,000

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING—Continued

Radionuclide	Quantity (μ Ci)
Dysprosium-159	100
Dysprosium-165	1,000
Dysprosium-166	100
Holmium-155	1,000
Holmium-157	1,000
Holmium-159	1,000
Holmium-161	1,000
Holmium-162m	1,000
Holmium-162	1,000
Holmium-164m	1,000
Holmium-164	1,000
Holmium-166m	1
Holmium-166	100
Holmium-167	1,000
Erbium-161	1,000
Erbium-165	1,000
Erbium-169	100
Erbium-171	100
Erbium-172	100
Thulium-162	1,000
Thulium-166	100
Thulium-167	100
Thulium-170	10
Thulium-171	10
Thulium-172	100
Thulium-173	100
Thulium-175	1,000
Ytterbium-162	1,000
Ytterbium-166	100
Ytterbium-167	1,000
Ytterbium-169	100
Ytterbium-175	100
Ytterbium-177	1,000
Ytterbium-178	1,000
Lutetium-169	100
Lutetium-170	100
Lutetium-171	100
Lutetium-172	100
Lutetium-173	10
Lutetium-174m	10
Lutetium-174	10
Lutetium-176m	1,000
Lutetium-176	100
Lutetium-177m	10
Lutetium-177	100
Lutetium-178m	1,000
Lutetium-178	1,000
Lutetium-179	1,000
Hafnium-170	100
Hafnium-172	1
Hafnium-173	1,000
Hafnium-175	100
Hafnium-177m	1,000
Hafnium-178m	0.1
Hafnium-179m	10
Hafnium-180m	1,000
Hafnium-181	10
Hafnium-182m	1,000
Hafnium-182	0.1
Hafnium-183	1,000
Hafnium-184	100
Tantalum-172	1,000
Tantalum-173	1,000
Tantalum-174	1,000
Tantalum-175	1,000
Tantalum-176	100
Tantalum-177	1,000
Tantalum-178	1,000
Tantalum-179	100
Tantalum-180m	1,000
Tantalum-180	100
Tantalum-182m	1,000
Tantalum-182	10
Tantalum-183	100
Tantalum-184	100
Tantalum-185	1,000

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING—Continued

Radionuclide	Quantity (μ Ci)
Tantalum-186	1,000
Tungsten-176	1,000
Tungsten-177	1,000
Tungsten-178	1,000
Tungsten-179	1,000
Tungsten-181	1,000
Tungsten-185	100
Tungsten-187	100
Tungsten-188	10
Rhenium-177	1,000
Rhenium-178	1,000
Rhenium-181	1,000
Rhenium-182 (12.7h)	1,000
Rhenium-182 (64.0h)	100
Rhenium-184m	10
Rhenium-184	100
Rhenium-185m	10
Rhenium-186	100
Rhenium-187	1,000
Rhenium-188m	1,000
Rhenium-188	100
Rhenium-189	100
Osmium-180	1,000
Osmium-181	1,000
Osmium-182	100
Osmium-185	100
Osmium-189m	1,000
Osmium-191m	1,000
Osmium-191	100
Osmium-193	100
Osmium-194	1
Indium-182	1,000
Indium-184	1,000
Indium-185	1,000
Indium-186	10 ³
Indium-187	10 ³
Indium-188	100
Indium-189	100
Indium-190m	1,000
Indium-190	100
Indium-192 (73.8d)	1
Indium-192m (1.4min.)	10
Indium-194m	10
Indium-194	100
Indium-195m	1,000
Indium-195	1,000
Platinum-186	1,000
Platinum-188	100
Platinum-189	1,000
Platinum-191	100
Platinum-193m	100
Platinum-193	1,000
Platinum-195m	100
Platinum-197m	1,000
Platinum-197	100
Platinum-199	1,000
Platinum-200	100
Gold-193	1,000
Gold-194	100
Gold-195	10
Gold-198m	100
Gold-198	100
Gold-199	100
Gold-200m	100
Gold-200	1,000
Gold-201	1,000
Mercury-193m	100
Mercury-193	1,000
Mercury-194	1
Mercury-195m	100
Mercury-195	1,000
Mercury-197m	100
Mercury-197	1,000
Mercury-199m	1,000
Mercury-203	100
Thallium-194m	1,000

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING—Continued

Radionuclide	Quantity (μ Ci)
Thallium-194	1,000
Thallium-195	1,000
Thallium-197	1,000
Thallium-198m	1,000
Thallium-198	1,000
Thallium-199	1,000
Thallium-200	1,000
Thallium-201	1,000
Thallium-202	100
Thallium-204	100
Lead-195m	1,000
Lead-198	1,000
Lead-199	1,000
Lead-200	100
Lead-201	1,000
Lead-202m	1,000
Lead-202	10
Lead-203	1,000
Lead-205	100
Lead-209	1,000
Lead-210	0.01
Lead-211	100
Lead-212	1
Lead-214	100
Bismuth-200	1,000
Bismuth-201	1,000
Bismuth-202	1,000
Bismuth-203	100
Bismuth-205	100
Bismuth-206	100
Bismuth-207	10
Bismuth-210m	0.1
Bismuth-210	1
Bismuth-212	10
Bismuth-213	10
Bismuth-214	100
Polonium-203	1,000
Polonium-205	1,000
Polonium-207	1,000
Polonium-210	0.1
Astatine-207	100
Astatine-211	10
Radon-220	1
Radon-222	1
Francium-222	100
Francium-223	100
Radium-223	0.1
Radium-224	0.1
Radium-225	0.1
Radium-226	0.1
Radium-227	1,000
Radium-228	0.1
Actinium-224	1
Actinium-225	0.01
Actinium-226	0.1
Actinium-227	0.001
Actinium-228	1
Thorium-226	10
Thorium-227	0.01
Thorium-228	0.001
Thorium-229	0.001
Thorium-230	0.001
Thorium-231	100
Thorium-232	100
Thorium-234	10
Thorium-natural	100
Protactinium-227	10
Protactinium-228	1
Protactinium-230	0.1
Protactinium-231	0.001
Protactinium-232	1
Protactinium-233	100
Protactinium-234	100
Uranium-230	0.01
Uranium-231	100
Uranium-232	0.001

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING—Continued

Radionuclide	Quantity (μ Ci)
Uranium-233	0.001
Uranium-234	0.001
Uranium-235	0.001
Uranium-236	0.001
Uranium-237	100
Uranium-238	100
Uranium-239	1,000
Uranium-240	100
Uranium-natural	100
Neptunium-232	100
Neptunium-233	1,000
Neptunium-234	100
Neptunium-235	100
Neptunium-236 (1.15x10 ⁶ y)	0.001
Neptunium-236 (22.5h)	1
Neptunium-237	1,001
Neptunium-238	10
Neptunium-239	100
Neptunium-240	1,000
Plutonium-234	10
Plutonium-235	1,000
Plutonium-236	0.001
Plutonium-237	100
Plutonium-238	0.001
Plutonium-239	0.001
Plutonium-240	0.001
Plutonium-241	0.01
Plutonium-242	0.001
Plutonium-243	1,000
Plutonium-244	0.001
Plutonium-245	100
Americium-237	1,000
Americium-238	100
Americium-239	1,000
Americium-240	100
Americium-241	0.001
Americium-242m	0.001
Americium-242	10
Americium-243	0.001

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING—Continued

Radionuclide	Quantity (μ Ci)
Americium-244m	100
Americium-244	10
Americium-245	1,000
Americium-246m	1,000
Americium-246	1,000
Curium-238	100
Curium-240	0.1
Curium-241	1
Curium-242	0.01
Curium-243	0.001
Curium-244	0.001
Curium-245	0.001
Curium-246	0.001
Curium-247	0.001
Curium-248	0.001
Curium-249	1,000
Berkelium-245	100
Berkelium-246	100
Berkelium-247	0.001
Berkelium-249	0.1
Berkelium-250	10
Berkelium-244	100
Californium-246	1
Californium-248	0.01
Californium-249	0.001
Californium-250	0.001
Californium-251	0.001
Californium-252	0.001
Californium-253	0.1
Californium-254	0.001
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.001
Einsteinium-250	100
Einsteinium-251	100
Einsteinium-253	0.1
Einsteinium-254m	1
Einsteinium-254	0.01
Fermium-252	1

APPENDIX C TO §§ 20.1001-20.2401
QUANTITIES¹ OF LICENSED MATERIAL
REQUIRING LABELING—Continued

Radionuclide	Quantity (μ Ci)
Fermium-253	1
Fermium-254	10
Fermium-255	1
Fermium-257	0.01
Mendelevium-257	10
Mendelevium-258	0.01
Any radionuclide other than alpha emitting radionuclides not listed above, or mixtures of beta emitters of unknown composition	0.01

¹ The quantities listed above were derived by taking 1/10th of the most restrictive ALI listed in table 1, columns 1 and 2, of appendix B to §§ 20.1001-20.2401 of this part, rounding to the nearest factor of 10, and arbitrarily constraining the values listed between 0.001 and 1,000 μ Ci. Values of 100 μ Ci have been assigned for radionuclides having a radioactive half-life in excess of 10⁶ years (except plutonium, 1,000 μ Ci) to take into account their low specific activity.

Note: For purposes of §§ 20.1902(e), 20.1905(a), and 20.2201(a) where there is involved a combination of radionuclides in known amounts, the limit for the combination should be derived as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed "1" (i.e., "unity").

Appendix D to §§ 20.1001-20.2401—
United States Nuclear Regulatory Commission Regional Offices

	Address	Telephone (24 hour)
Region I: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.	USNRC, Region I, 475 Allendale Road, King of Prussia, PA 19406.	(215) 337-5000, (FTS) 346-5000.
Region II: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia.	USNRC, Region II, 101 Marietta Street, NW., Suite 2900, Atlanta, GA 30323.	(404) 331-4503, (FTS) 841-4503.
Region III: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.	USNRC, Region III, 799 Roosevelt Road, Glen Ellyn, IL 60137.	(708) 790-5500, (FTS) 386-5500.
Region IV: Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming.	USNRC, Region IV, 611 Ryan Plaza Drive, Suite 1000, Arlington, TX 78011.	(817) 860-8100, (FTS) 728-8100.
Region IV: Field Office	USNRC, Region IV, Uranium Recovery Field Office, 730 Simms Street, Suite 100a, Golden, CO 80401, Mail P.O. Box 25325, Denver, CO 80225.	(303) 231-5800, (FTS) 554-2805.
Region V: Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington, and U.S. territories and possessions in the Pacific.	USNRC, Region V, 1450 Main Lane, Suite 210, Walnut Creek, CA 94596.	(415) 975-0200.

Appendix E to §§ 20.1001-20.2401
[Reserved]Appendix F to §§ 20.1001-20.2401—
Requirements for Low-Level-Waste
Transfer for Disposal at Land Disposal
Facilities and Manifests

I. Manifest

The shipment manifest shall contain the name, address, and telephone number of the person generating the waste. The manifest shall also include the name, address, and telephone number or the name and EPA hazardous waste identification number of the

person transporting the waste to the land disposal facility. The manifest must also indicate as completely as practicable: a physical description of the waste, the volume, radionuclide identity and quantity, the total radioactivity, and the principal chemical form. The solidification agent must be specified. Waste containing more than 0.1% chelating agents by weight must be identified and the weight percentage of the chelating agent estimated. Wastes classified as Class A, Class B, or Class C in § 61.55 of this

chapter must be clearly identified as such in the manifest. The total quantity of the radionuclides ^3H , ^{14}C , ^{90}Sr , and ^{137}Cs must be shown. The manifest required by this paragraph may be shipping papers used to meet Department of Transportation or Environmental Protection Agency regulations or requirements of the receiver, provided all the required information is included. Copies of manifests required by this section may be legible carbon copies or legible photocopies.

II. Certification

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

III. Control and Tracking

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

1. Prepare all wastes so that the waste is classified according to § 61.55 of this chapter and meets the waste characteristics requirements in § 61.56 of this chapter;
 2. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with § 61.55 of this chapter;
 3. Conduct a quality control program to ensure compliance with §§ 61.55 and 61.56 of this chapter; the program must include management evaluation of audits;
 4. Prepare shipping manifests to meet the requirements of sections I and II of this appendix;
 5. Forward a copy of the manifest to the intended recipient, at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgment of receipt in the form of a signed copy of the manifest or equivalent documentation from the collector;
 6. Include one copy of the manifest with the shipment;
 7. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by parts 30, 40, and 70 of this chapter; and
 8. For any shipments or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this section, conduct an investigation in accordance with paragraph E of this appendix.
- B. Any waste collector licensee who handles only prepackaged waste shall:
1. Acknowledge receipt of the waste from the generator within 1 week of receipt by returning a signed copy of the manifest or equivalent documentation;

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

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

4. Include the new manifest with the shipment to the disposal site;

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

6. For any shipments or any part of a shipment for which acknowledgment of receipt is not received within the times set forth in this section, conduct an investigation in accordance with section III. E of this appendix.

C. Any licensed waste processor who treats or repackages wastes shall:

1. Acknowledge receipt of the waste from the generator within 1 week of receipt by returning a signed copy of the manifest or equivalent documentation;
 2. Prepare a new manifest that meets the requirements of sections I and II of this appendix. Preparation of the new manifest reflects that the processor is responsible for the waste;
 3. Prepare all wastes so that the waste is classified according to § 61.55 of this chapter and meets the waste characteristics requirements in § 61.56 of this chapter;
 4. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with §§ 61.55 and 61.57 of this chapter;
 5. Conduct a quality control program to ensure compliance with §§ 61.55 and 61.56 of this chapter. The program shall include management evaluation of audits;
 6. Forward a copy of the new manifest to the disposal site operator or waste collector at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgment of receipt in the form of a signed copy of the manifest or equivalent documentation by the collector;
 7. Include the new manifest with the shipment;
 8. Retain copies of original manifests and new manifests and documentation of acknowledgment of receipt as the record of transfer of licensed material required by parts 30, 40, and 70 of this chapter; and
 9. For any shipment or part of a shipment for which acknowledgment is not received within the times set forth in this section, conduct an investigation in accordance with section III. E of this appendix.
- D. The land disposal facility operator shall:
1. Acknowledge receipt of the waste within 1 week of receipt by returning a signed copy

of the manifest or equivalent documentation to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. The returned copy of the manifest or equivalent documentation shall indicate any discrepancies between materials listed on the manifest and materials received;

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

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

E. Any shipment or part of a shipment for which acknowledgment is not received within the times set forth in this section must:

1. Be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and
2. Be traced and reported. The investigation shall include tracing the shipment and filing a report with the nearest Commission Regional Office listed in appendix D to this part. Each licensee who conducts a trace investigation shall file a written report with the appropriate NRC Regional Office within 2 weeks of completion of the investigation.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
RADIOACTIVE EVALUATION OF DEVICE

NO.: NR-210-D-101-E

DATE: JAN 05 1993

PAGE 1 OF 2

DEVICE TYPE: SELF-LUMINOUS COMPASS

MODEL: 13208E4680

MANUFACTURER/DISTRIBUTOR:

Cammenga and Associates, Inc.
100 Aniline Avenue N.
Holland, MI 49424

SEALED SOURCE MODEL DESIGNATION: mb/Microtec: 400/6,400/3,400/1

ISOTOPE:

Hydrogen-3

MAXIMUM ACTIVITY:

120 mCi (4.44 GBq)

LEAK TEST FREQUENCY: Not Required

PRINCIPAL USE: (W) - Self Luminous Applications

CUSTOM DEVICE:

_____ YES _____ X _____ NO

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
RADIOACTIVE EVALUATION OF DEVICE

NO.: NR-210-D-101-E

DATE: JAN 05 1993

PAGE 2 OF 2

DEVICE TYPE: SELF-LUMINOUS COMPASS

DESCRIPTION:

The compass is made of a die-cast aluminum cover and case. The cover is hinged to the case of the compass, and folds over the case for storage. When folded, the compass measures approximately 3 inches (7.62 cm) x 3 inches (7.62 cm) x 2 inches (5.08 cm).

The case is made of a die-cast aluminum case bottom, rubber seal cup, damping shell, dial, dial cover, and bezel assembly. The dial is inserted into a hole in the damping shell so that it can turn freely, then the dial cover is placed on top of the damping shell. The seal cup is then placed over the entire assembly. The case bottom is then attached. A rubber seal cup is compressed between the damping shell and case bottom as four screws that hold the shell and case bottom together are tightened.

Seven Hydrogen-3 (tritium) vials, with a total activity of 120 millicuries (4.44 GBq) are used as light sources for viewing the compass under dark conditions. The vials used are manufactured by mb/Microtec of Bern, Switzerland (models 400/1, 400/3, and 400/6). All these vials are held in place with silicone adhesive.

REFERENCES:

The following supporting documents for model 13208E4680 are hereby incorporated by reference and are made a part of this registry document.

- Cammenga and Associates, Inc.'s letters and facsimile transmissions dated November 14, 1992, December 16, 1992, and December 28, 1992.

ISSUING AGENCY:

U.S. Nuclear Regulatory Commission

Date: JAN 05 1993

Reviewer: *John Dwyer*

Date: JAN 05 1993

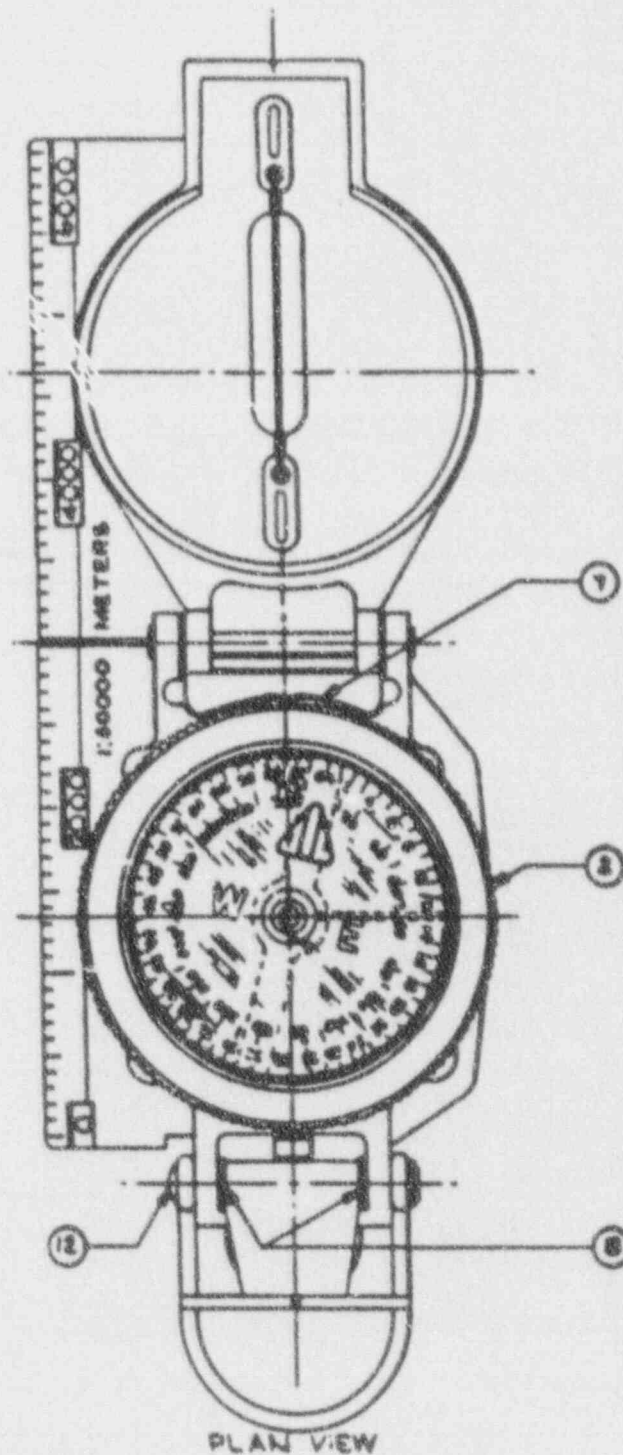
Concurrence: *Douglas A. Ball*

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-210-D-101-E

DATE: JAN 05 1993

ATTACHMENT 1

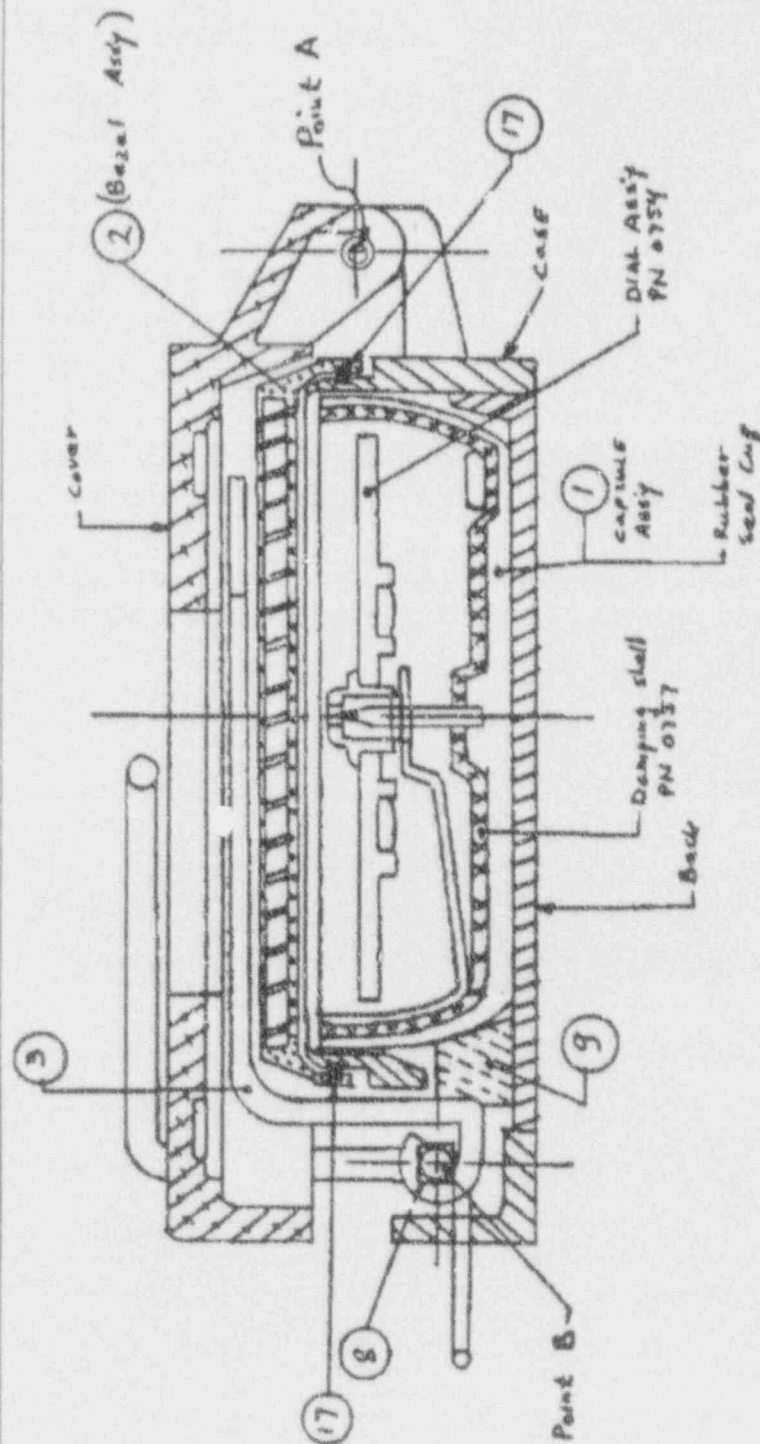


REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-210-D-101-E

DATE: JAN 05 1993

ATTACHMENT 2



REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO: NR-155-D-118-S

DATE: JUN 15 1983

PAGE 1 OF 4

DEVICE TYPE: Chemical Agent Detector

MODEL: MSA1

DISTRIBUTOR:

Department of the Army
U.S. Army Armament Material Readiness Command
(DRSAR-SF)
Rock Island, IL 61299

MANUFACTURER:

Any specific licensee of the NRC or an
Agreement State that is under contract
to the Department of the Army.

SEALED SOURCE MODEL DESIGNATION:

Amersham Corporation Foil Source Model AMM1001

ISOTOPE: Americium-241

MAXIMUM ACTIVITY: 250 microcuries

LEAK TEST FREQUENCY: 36 months (see Limitations and/or Other Considerations of Use)

PRINCIPAL USE: (P) Ion Generators, Smoke Detectors

CUSTOM DEVICE: ☒ YES ☐ NO

CUSTOM USER:

U.S. Department of Defense

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO: NA-155-D-118-S

DATE:

JUN 15 1983

PAGE 2 OF 4

DEVICE TYPE: Chemical Agent Detector

DESCRIPTION:

The Model M43A1 chemical agent detector is made up of three major components: (1) the electronics package, (2) the air pump assembly and (3) the detector cell assembly which contains the Americium source. These three components are secured in a high impact plastic case. The use of these components allows rapid non-technical repair of a unit in the field. The device also has an optional battery pack that can be secured to the bottom of the device or it can be powered by a 24-volt supply line. The device can be a portable unit or a mounted at a fixed location, depending on the situation. The unit has been constructed using materials that provide for its use in a wide range of environs.

LABELING:

The source housing is labeled with the trefoil symbol isotope, activity, date of assay, the words, "Caution-Radioactive Material," and the words, "Radiation Exposure Can Occur When Cell Module Is Opened, Cell Module Should Not Be Dis-Assembled." Additionally, the outside of the case is labeled with the isotope, activity, trefoil symbol, the words, "Caution-Radioactive Material," the words, "Control Disposal Required," and the words, "If Found, Return To Nearest Military Activity."

DIAGRAM:

See attachment.

CONDITIONS OF NORMAL USE:

The device will be used in ambient environmental conditions throughout the world as an automatic chemical agent alarm.

PROTOTYPE TESTING:

The foil source design used in the device has been deemed acceptable for licensing purposes by the NRC. See registration sheet No. NR-136-S-174-U for additional information. Additionally, the Radiochemical Center in England (Amersham) subjected the foil source to the following tests:

- o Specified form per requirements of IAEA transportation.
- o Isotope testing in accordance with 1968 requirements.
- o Exposure to sulphur dioxide, ammonia, hydrogen sulfide, hydrochloric acid, salt spray, and ozone.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO: NR-155-D-118-S

DATE: JUN 15 1983

PAGE 3 OF 4

DEVICE TYPE: Chemical Agent Detector

PROTOTYPE TESTING (Cont'd):

- o Immersion in simulated body fluid.
- o Abrasion tests
- o Elevated temperature tests up to 1200°C.
- o Vibration tests
- o Exposure to cleaning fluids, ethyl acetate, trichloroethylene.

The manufacturer reported no leakage above .005 microcuries for any of the foil sources tested.

The entire device was subjected to environmental testing as required by Military Standard 810C. The device was subjected to tests that simulated the worst conditions that may arise during field use. Devices were smear tested after each test. No leakage in excess of .005 microcuries was reported.

EXTERNAL RADIATION LEVELS:

The Department of the Army reports that:

- o The maximum radiation dose from the detector is 0.6 mr/hr at the surface, .04 mr/hr at six inches and 0.005 mr/hr at 36 inches.
- o The maximum radiation dose rate from the cell module (source housing) are 1.4 mr/hr at the surface, 0.7 mr/hr at six inches and 0.06 mr/hr at 36 inches.

These readings were taken directly in front of the foil face. In other directions the levels are insignificant.

QUALITY ASSURANCE AND CONTROL:

The devices are to be manufactured by a company under contract to the U.S. Department of the Army. The contract clearly specifies what is to be the acceptable specifications of the device. Also, devices are periodically tested by the Army to ensure that they meet these specifications. Any device that does not meet the specifications is deemed not acceptable for use until the problem can be corrected by the manufacturer.

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE:

- o The device shall be distributed by the Department of the Army Hq, U.S. Army Armament Material Readiness Command, Rock Island, IL., for use by the Department of Defense anywhere deemed acceptable by the licensee.
- o Handling, storage, use, transfer, and disposal shall be determined by the licensing authority.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO: NR-155-D-118-S

DATE: JUN 15 1983

PAGE 4 OF 4

DEVICE TYPE: Chemical Agent Detector

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE (Cont'd):

- o The areas where the cell modules are repaired or stored should be tested for removable contamination at a time interval to be determined by the Department of the Army, Radiation Safety staff.
- o This registration sheet and the information contained within the references shall not be changed or transferred without the written consent of the NRC.
- o In view of the extended leak test interval, the applicant should develop an accountability control program to keep track of all devices in storage and use.
- o The devices shall be leak tested at 36-month intervals using procedures as describe in the licensee's application dated March 29, 1982.

SAFETY ANALYSIS SUMMARY:

The Model M43A1 chemical agent detector has been designed to give fast, accurate readings of the concentration of specific gases and to warn of concentration that may be hazardous to the persons deployed in that area.

Based on our review of the information and test data cited below, and that the device will be used by persons trained in its use, we conclude that the chemical agent detector design is acceptable for licensing purposes.

Furthermore, we conclude that the devices would be expected to maintain their containment integrity of the source for the uses specified in this certificate.

REFERENCES:

The following supporting documents for the Model M43A1 chemical agent detector are hereby incorporated by reference and are made a part of this registry document:

- o U.S. Department of the Army, Hq., ARRCOM, Rock Island, IL., application dated March 29, 1982, with enclosures thereto and letter dated June 3, 1983.

ISSUING AGENCY:

U.S. Nuclear Regulatory Commission

JUN 15 1983

Date: _____

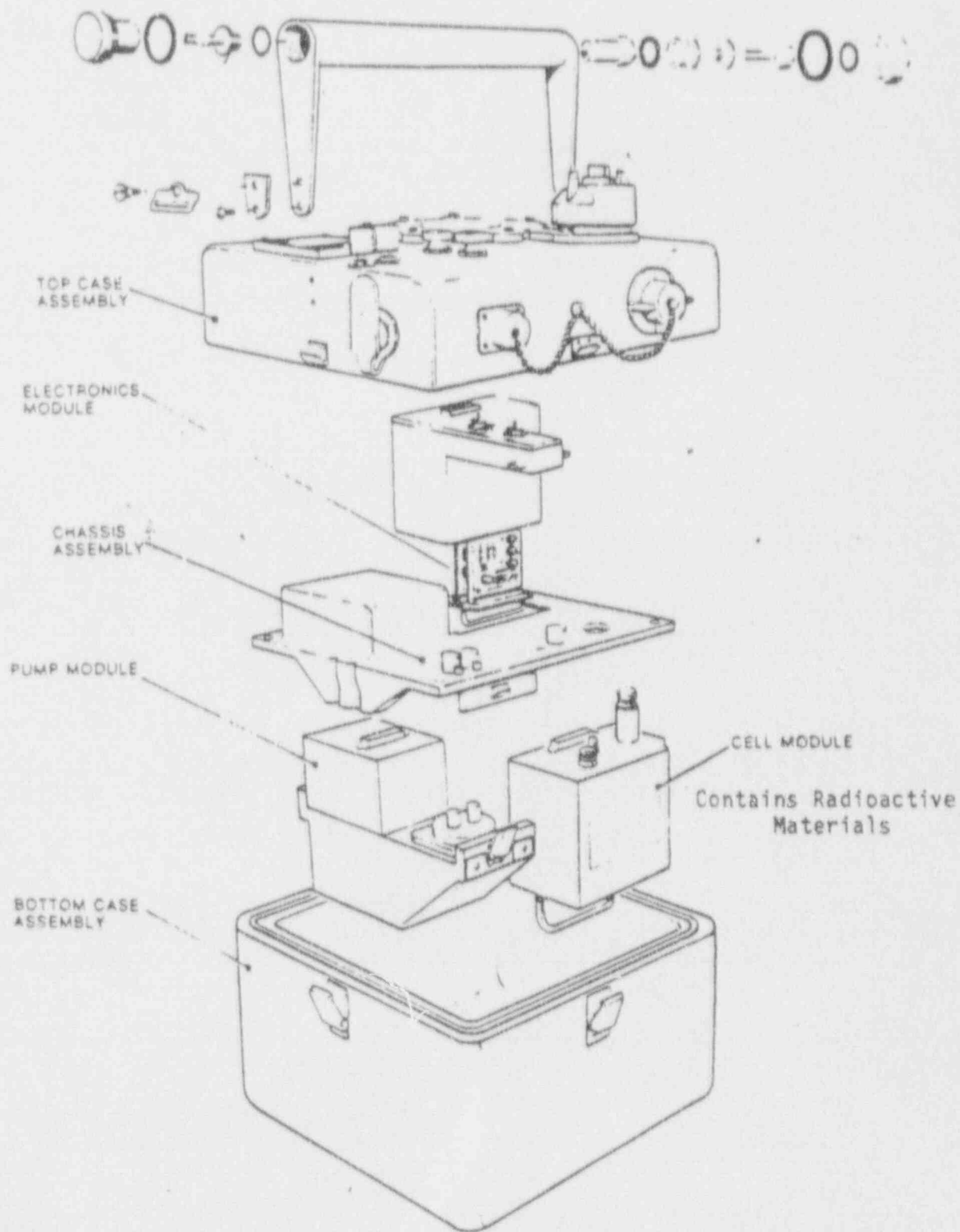
Reviewer: _____

JUN 15 1983

Date: _____

Concurrence: _____

Alton Bayle
Joseph H. Brown



Isometric Sketch of the M43A1 Detector Unit