

October 11, 2000

Frederick C. Combs, Deputy Director
U.S. Nuclear Regulatory Commission

Dear Mr. Combs:

This is a follow-up confirmation that a copy of the Nebraska Regulations for Control of Radiation-Ionizing (180 NAC 1) was mailed to you on September 26, 2000. This set of regulations includes approved changes dated May 27, 2000.

Also, please note this letter is to respond to STP letter dated December 7, 1999, regarding review of final regulations (as stated in paragraph 3 of the December 7, 1999 letter).

Should you have any questions, please contact his office at 402-471-6430.

Sincerely,

Cheryl K. Rogers, Program Manager
Radioactive Materials Program

e-mail copy: Kevin Hsueh

STATE OF NEBRASKA
REGULATIONS FOR CONTROL OF RADIATION - IONIZING

<u>SECTIONS</u>		<u>EFFECTIVE DATES</u>
LICENSING REGISTRATION		OCTOBER 1, 1966 JANUARY 1, 1967
REVISED	ALL SECTIONS	JANUARY 1, 1974
REVISED	SECTIONS A, B, C, D, E, G, AND J	AUGUST 22, 1982
REVISED	SECTIONS F, H, AND I	JUNE 27, 1983
REVISED	ALL SECTIONS	NOVEMBER 25, 1990
REVISED	SECTION 011	OCTOBER 27, 1993
REVISED	SECTIONS 001, 003, 004, 005, 006 (Pages 6-1, 6-2, 6-17 through 6-28, 6-41, 6-42, 6-53, 6-54, 6-73 and 6-74), SECTIONS 007, 008, 009, 010, 012, 014 AND 017	MAY 30, 1994

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TITLE 180
NEBRASKA DEPARTMENT OF HEALTH AND HUMAN SERVICES REGULATION AND LICENSURE
CONTROL OF RADIATION/REGULATIONS

CHAPTER 1 - REGULATIONS FOR CONTROL OF RADIATION - IONIZING

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Registration of Radiation Generating Equipment Facilities and Services.	71-3505(1) 71-3507	002
Licensing of Radioactive Material.	71-3505(1) 71-3508	003
Standards for Protection Against Radiation.	71-3505(1) 71-3507 71-3508	004
Radiation Safety Requirements for Industrial Radiographic Operations.	71-3505(1) 71-3507 71-3508	005
X-Rays in the Healing Arts.	71-3505(1) 71-3507 71-3508	006
Use of Radionuclides in the Healing Arts.	71-3505(1) 71-3508	007
Radiation Safety Requirements for Analytical X-Ray Equipment.	71-3505(1) 71-3507 71-3508	008
Radiation Safety Requirements for Particle Accelerators.	71-3505(1) 71-3507 71-3508	009
Notices, Instructions and Reports to Workers; Inspections.	71-3505(1) 71-3507 71-3508(2)	010
Requirements for Radon and Radon Progeny Measurement and Mitigation Services.	71-3501 71-3502 71-3505(1) 71-3507	011

<u>SUBJECT</u>	<u>STATUTORY AUTHORITY</u>	<u>CODE SECTION</u>
Licensing Requirements for Management of Radioactive Waste.	71-3501(1) 71-3508.01 71-3508.02 71-3508.04	012
Transportation of Radioactive Material.	71-3501(1)	013
Radiation Safety Requirements for Well Logging and Subsurface Tracer Studies.	71-3505(1) 71-3507	014
Training and Experience Requirements for Use of Radiation Sources.	71-3508	015
Limited X-Ray System Operator and X-Ray System Operator.	71-3515.01 71-3515.02	016
Enforcement of Radiation Control Act and Rights to Hearing Procedures for Licensees and Registrants; Penalties.	71-3513 71-3514 71-3516 71-3517	017
Fees for Certificates of Registration, Radioactive Material(s) Licenses, Environmental Surveillance, Emergency Response and Other Regulatory Services.	71-3508.03	018
Licenses and Radiation Safety Requirements for Irradiators.	71-3501(1) 71-3505 71-3507 71-3508	019

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ADDED	SECTION 019	OCTOBER 30, 1996
REVISED	SECTIONS 001, 003, 004, 007, 009, 012, 015 FORMS NRH-3, NRH-5, NRH-5 (Medical/Teletherapy), NRH-5 (Medical/Teletherapy) Supplement A, NRH-5 (Medical/Teletherapy) Supplement B, NRH-9, NRH-11, NRH-17	SEPTEMBER 17, 1997
ADDED	FORM NRH-5 (Medical/Teletherapy) Supplement C, NRH-60	SEPTEMBER 17, 1997
DELETED	FORMS NRH-5 (Teletherapy) Supplement A, NRH-5 (Teletherapy) Supplement B	SEPTEMBER 17, 1997
REVISED	SECTIONS 004, 010, 012, AND 013 SECTION 004 (Appendix 004-C and 004-D) SECTION 013 (Table A-1 and A-2)	DECEMBER 15, 1998
ADDED	SECTION 004 (FORMS 540, 540A, 541, 541A, 542 and 542A)	

REVISED	SECTIONS 001, 002, 003, 004, 005, 006, 007, 008, 009, 010, 011, 012, 013, 014, 015, 017, 018, 019 FORMS NRH-3, NRH-5, NRH-5A (Teletherapy) and supplements A through C, NRH-9, NRH-11, NRH-17, and NRH-60.	May 27, 2000
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TITLE 180, NEBRASKA ADMINISTRATIVE CODE, CHAPTER 1

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TITLE 180 - NEBRASKA HEALTH AND HUMAN SERVICES REGULATION AND LICENSURE

CHAPTER 1 - REGULATIONS FOR CONTROL OF RADIATION - IONIZING

SECTION 001 GENERAL PROVISIONS

001.01 Purpose and Scope. Except as otherwise specifically provided, these regulations apply to all persons who receive, possess, use, transfer, own, or acquire: (1) any radiation generating equipment; (2) any naturally occurring or accelerator produced radioactive material; and (3) any radioactive: (a) source material; (b) byproduct material; and, (c) special nuclear material; in quantities not sufficient to form a critical mass.

001.02 Definitions. As used in these regulations, these terms have the definitions set forth below. Additional definitions used only in a certain section will be found in that section.

"A₁" means the maximum activity of special form radioactive material permitted in a Type A package. "A₂" means the maximum activity of radioactive material, other than special form radioactive material, permitted in a Type A package. These values are either listed in Appendix A of Section 013 of these regulations, Table A-1, or may be derived in accordance with the procedure prescribed in Appendix A of Section 013 of these regulations.

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

"Accelerator" means any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium. For purposes of this definition, "Particle accelerator" is an equivalent term.

"Accelerator produced material" means any material made radioactive by a particle accelerator.

"Act" means Radiation Control Act. Sections 71-3501 to 71-3520, Reissue Revised Statutes of Nebraska, 1943. As amended.

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

"Adult" means an individual 18 or more years of age.

"Agency" means the Department of Health and Human Services Regulation and Licensure.

"Agreement State" means any State with which the U.S. Nuclear Regulatory Commission or the U.S. Atomic Energy Commission has entered into an effective agreement under subsection 274b. of the Atomic Energy Act of 1954, as amended (73 Stat. 689).

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

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"Airborne radioactivity area" means a room, enclosure, or area in which airborne radioactive materials exist in concentrations:

- (1) In excess of the derived air concentrations (DACs) specified in Appendix B, Table I of Section 004 of these regulations, 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.

"As low as is reasonably achievable" (ALARA) means making every reasonable effort to maintain exposures to radiation as far below the dose limits in these regulations as is practical, consistent with the purpose for which the licensed or registered 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 or registered sources of radiation in the public interest.

"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 including global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the licensee. "Background radiation" does not include sources of radiation from radioactive materials regulated by the Agency.

"Becquerel" (Bq) means the SI unit of activity. One becquerel is equal to 1 disintegration or transformation per second (dps or tps).

"Bioassay" 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. For purposes of these regulations, "radiobioassay" is an equivalent term.

"Brachytherapy" means a method of radiation therapy in which sealed sources are utilized to deliver a radiation dose at a distance of up to a few centimeters, by surface, intracavitary, or interstitial application.

"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 or thorium solution extraction processes. Underground ore bodies depleted by solution extraction operations do not constitute byproduct material.

"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 so arranged such that no day is included in more than one calendar quarter and no day in any one year is omitted from inclusion within a calendar quarter. No licensee or registrant shall change their method for determining calendar quarters except at the beginning of a year.

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"Calibration" means the determination of (1) the response or reading of an instrument relative to a series of known radiation values over the range of the instrument, or (2) the strength of a source of radiation relative to a standard.

"CFR" means Code of Federal Regulations.

"Chelating agent" means amine polycarboxylic acids, hydroxycarboxylic acids, gluconic acid, and polycarboxylic acids.

"Civil penalty" means any monetary penalty levied on a licensee or registrant because of violations of statutes, rules, regulations, licenses, or registration certificates, but does not include criminal penalties.

"Collective dose" means 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.

"Committed dose equivalent" (CDE) ($H_{T,50}$) 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" (CEDE) ($H_{E,50}$) 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 each of these organs or tissues ($H_{E,50} = \sum w_T H_{T,50}$).

"Constraint" (dose constraint) means a value above which specified licensee actions are required.

"Critical Group" means the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances."

"Curie" means a unit of quantity of radioactivity. One curie (Ci) is that quantity of radioactive material which decays at the rate of $3.7E+10$ disintegrations or transformations per second (dps or tps).

"Custodial care" means the continued observation, monitoring, and care of a management facility for a minimum of one hundred years following transfer of ownership of the management facility from the operator to the Agency.

"Decommission" means to remove a facility or site safely from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use or release of the property under restricted conditions and termination of license.

"Decommissioning" means final operational activities at a facility to dismantle site structures, to decontaminate site surfaces and remaining structures, to stabilize and contain residual radioactive material, and to carry out any other activities to prepare the site for postoperational care.

"Deep dose equivalent" (DDE) (H_d), which applies to external whole body exposure, means the dose equivalent at a tissue depth of 1 centimeter (1000 mg/cm^2).

"Depleted uranium" means the source material uranium in which the isotope uranium-235 is less than 0.711 weight percent of the total uranium present. Depleted uranium does not include special nuclear material.

"Director" means Director of Regulation and Licensure.

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"Distinguishable from background" means that the detectable concentration of a radionuclide is statistically different from the background concentration of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques."

"Dose" is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, total organ dose equivalent, or total effective dose equivalent. For purposes of these regulations, "radiation dose" is an equivalent term.

"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 sievert (Sv) and rem.

"Dose limits" means the permissible upper bounds of radiation doses established in accordance with these regulations. For purposes of these regulations, "limits" is an equivalent term.

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

"Electronic product" means any manufactured product, device, assembly, or assemblies of such products or devices which, during operation in an electronic circuit, can generate or emit a physical field of radiation.

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

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

"Explosive material" means any chemical compound, mixture, or device which produces a substantial instantaneous release of gas and heat spontaneously or by contact with sparks or flame.

"E (Exponent)" indicates that the number 10 is to be raised to a given power. This power is indicated to the right of the symbol E. For example: $3E+4$ symbolizes 3×10^4 and $3E-4$ symbolizes 3×10^{-4} .

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

"Exposure"¹ means the quotient of dQ by dm where " dQ " is the absolute value of the total charge of the ions of one sign produced in air when all the electrons (negatrons and positrons) liberated by photons in a volume element of air having mass " dm " are completely stopped in air. The SI unit of exposure is the coulomb per kilogram (C/kg). See 001.15A Units of Exposure and Dose for the special unit .

"Exposure rate" means the exposure per unit of time, such as roentgen per minute (R/min) or milliroentgen per hour (mR/h).

"External dose" means that portion of the dose equivalent received from any source of radiation outside the body.

¹When not underlined as above [or indicated as "exposure" (X)] the term "exposure" has a more general meaning in these regulations.

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

"Eye dose equivalent" (LDE) means the external dose equivalent to the lens of the eye at a tissue depth of 0.3 centimeter (300 mg/cm²).

"Former U.S. Atomic Energy Commission (AEC) or U.S. Nuclear Regulatory Commission (NRC) licensed facilities" means nuclear reactors, nuclear fuel reprocessing plants, uranium enrichment plants, or critical mass experimental facilities where AEC or NRC licenses have been terminated.

"Generally applicable environmental radiation standards" means standards issued by the U.S. 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.

"Gray" (Gy) means the SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (100 rad).

"Hazardous waste" means those wastes designated as hazardous in 40 CFR Chapter I, Part 261, Subpart A, Sections 261.2 - 261.4 and Subpart D, attached hereto as Attachment Number 1 and incorporated herein by this reference.

"Healing arts" means diagnostic and/or healing treatment of human and animal maladies including but not limited to the following which are duly licensed by the State of Nebraska for the lawful practice of: medicine and its associated specialties, dentistry, veterinary medicine, osteopathy, chiropractic, and podiatry.

"High-level radioactive waste" means:

- (1) Irradiated reactor fuel;
- (2) Liquid wastes resulting from the operation of the first cycle solvent extraction system or equivalent and the concentrated wastes from subsequent extraction cycles or the equivalent in a facility for reprocessing irradiated reactor fuel; and
- (3) Solids into which such liquid wastes have been converted.
- (4) Other highly radioactive waste material as defined by the U.S. Nuclear Regulatory Commission.

"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 1 mSv (0.1 rem) in 1 hour at 30 centimeters from any source of radiation or from any surface that the radiation penetrates.

"Human use" means the internal or external administration of radiation or radioactive material to human beings.

"Individual" means any human being.

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"Individual monitoring" means the assessment of:

- (1) Dose equivalent (a) by the use of individual monitoring devices or (b) by the use of survey data; or
- (2) Committed effective dose equivalent (a) by bioassay or (b) by determination of the time-weighted air concentrations to which an individual has been exposed, that is, DAC-hours. [See the definition of DAC-hours in Section 004].

"Individual monitoring devices" means devices designed to be worn by a single individual for the assessment of dose equivalent. For the purposes of these regulations, "personnel dosimeter" and "dosimeter" are equivalent terms. Examples of individual monitoring devices are film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers, and personal air sampling devices.

"Inspection" means an official examination or observation including, but not limited to, tests, surveys, and monitoring to determine compliance with rules, regulations, orders, requirements, and conditions of the Agency. The licensee or registrant is notified of any items of noncompliance and/or recommendation of the Agency.

"Interlock" means a device arranged or connected such that the occurrence of an event or condition is required before a second event or condition can occur or continue to occur.

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

"License" means a license issued by the Agency in accordance with the regulations adopted by the Agency.

"Licensed material" means radioactive material received, possessed, used, transferred or disposed of under a general or specific license issued by the Agency.

"Licensed practitioner" means a person licensed to practice medicine, dentistry, podiatry, chiropractic, osteopathic medicine and surgery, or as an osteopathic physician.

"Licensee" means any person who is licensed by the Agency in accordance with these regulations and the Act.

"Limits" [See "Dose limits"].

"Lost or missing source of radiation" means source of radiation whose location is unknown. This definition includes licensed material that has been shipped but has not reached its planned destination and whose location cannot be readily traced in the transportation system.

"Low-level radioactive waste" means radioactive waste not defined as high-level radioactive waste, spent nuclear fuel, or byproduct material as defined in Subsection 001.02 "byproduct material (2)" of these regulations.

"Major processor" means a user processing, handling, or manufacturing radioactive material exceeding Type A quantities as unsealed sources or material, or exceeding 4 times Type B quantities as sealed sources, but does not include nuclear medicine programs, universities, industrial radiographers, or small industrial programs. Type A and B quantities are defined in Section 013 Part 013.02N and 013.02O of these regulations and in 10 CFR Chapter I, Part 71, Subpart A, Section 71.4 attached hereto as part of Attachment Number 2 and incorporated herein by this reference.

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"Management facility" means the land, buildings, and equipment which is intended to be used for the management of radioactive wastes.

"Management of low-level radioactive waste" means the handling, processing, storage, reduction in volume, disposal, or isolation of such waste from the biosphere in any manner, except the commercial disposal of low-level radioactive waste in a disposal facility, designated by the Central Interstate Low-Level Radioactive Waste Compact Commission.

"Member of the public" means any individual except when that individual is receiving an occupational dose.

"Minor" means an individual less than 18 years of age.

"Mixed waste" means low-level radioactive waste that also contains hazardous waste that is identified in Title 128, Nebraska Administrative Code.

"Monitoring" means the measurement of radiation, radioactive material concentrations, surface area activities or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses. For the purposes of these regulations, radiation monitoring and radiation protection monitoring are equivalent terms.

"NARM" means any naturally occurring or accelerator-produced radioactive material. It does not include byproduct, source, or special nuclear material.

"Natural radioactivity" means radioactivity of naturally occurring nuclides.

"Nuclear Regulatory Commission" (NRC) means the U.S. Nuclear Regulatory Commission or its duly authorized representatives.

"Occupational dose" means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to sources of radiation from licensed or unlicensed sources of radiation, whether in the possession of the licensee, registrant, or other person. Occupational dose does not include doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with Subsection 007.30, from voluntary participation in medical research programs, or as a member of the public.

"Package" means the packaging together with its radioactive contents as presented for transport.

"Particle accelerator" [See "Accelerator"]

"Person" means any individual, corporation, partnership, limited liability company, firm, association, trust, estate, public or private institution, group, agency, political subdivision of this State, any other State or political subdivision or agency thereof, and any legal successor, representative, agent, or agency of the foregoing.

"Personnel monitoring equipment" [See Individual monitoring devices].

"Pharmacist" means an individual licensed by this State to compound and dispense drugs, prescriptions, and poisons.

"Physician" means an individual licensed by this State to dispense drugs in the practice of medicine.

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"Public dose" means the dose received by a member of the public from exposure to sources of radiation released by a licensee or registrant, or to any other source of radiation under the control of a licensee or registrant. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with Subsection 007.30, or from voluntary participation in medical research programs.

"Pyrophoric liquid" means any liquid that ignites spontaneously in dry or moist air at or below 130°F (54.4 °C). A pyrophoric solid is any solid material, other than one classed as an explosive, which under normal conditions is liable to cause fires through friction, retained heat from manufacturing or processing, or which can be ignited readily and, when ignited, burns so vigorously and persistently as to create a serious transportation, handling, or disposal hazard. Included are spontaneously combustible and water-reactive materials.

"Quality factor" (Q) means the modifying factor, listed in Tables I and II of 001.15, that is used to derive dose equivalent from absorbed dose.

"Rad" means the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 erg per gram or 0.01 joule per kilogram (0.01 gray).

"Radiation" means ionizing and nonionizing radiation as follows: (a) ionizing radiation means gamma rays, x-rays, alpha and beta particles, high-speed electrons, neutrons, protons, and other atomic or nuclear particles or rays, but shall not include sound or radiowaves or visible, infrared, or ultraviolet light; and (b) nonionizing radiation means (i) any electromagnetic radiation which can be generated during the operations of electronic products to such energy density levels as to present a biological hazard to occupational and public health and safety and the environment, other than ionizing electromagnetic radiation, and (ii) any sonic, ultrasonic, or infrasonic waves which are emitted from an electronic product as a result of the operation of an electronic circuit in such product and to such energy density levels as to present a biological hazard to occupational and public health and safety, and the environment.

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

"Radiation Dose" [See "Dose"].

"Radiation generating equipment" means any manufactured product or device, component part of such a product or device, or machine or system which during operation can generate or emit radiation except devices which emit radiation only from radioactive material.

"Radiation safety officer" means an individual who has the knowledge and responsibility to apply appropriate radiation protection regulations.

"Radioactive material" means any material whether solid, liquid, or gas, which emits ionizing radiation spontaneously. Radioactive material includes, but is not limited to, accelerator-produced material, byproduct material, naturally occurring material, source material, and special nuclear material.

"Radioactivity" means the transformation of unstable atomic nuclei by the emission of radiation.

"Radiobioassay". [See "Bioassay"].

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"Registrant" means any person who is registered with the Agency and is legally obligated to register with the Agency pursuant to these regulations and the Act.

"Registration" means registration with the Agency pursuant to the Act and in accordance with the regulations adopted by the Agency.

"Regulations of the U.S. Department of Transportation" means the regulations in 49 CFR Parts 100-189.

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

"Research and development" means (1) theoretical analysis, exploration, or experimentation; or (2) the extension of investigative findings and theories of a scientific or technical nature into practical application for experimental and demonstration purposes, including the experimental production and testing of models, devices, equipment, materials, and processes. Research and development does not include the internal or external administration of radiation or radioactive material to human beings.

"Residual radioactivity" means radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the licensee's control. This includes radioactivity from all licensed and unlicensed sources used by the licensee, but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 180 NAC 1-004.

"Restricted area" means an area, access to which is limited by the licensee or registrant for the purpose of protecting individuals against undue risks from exposure to sources of radiation. 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.

"Roentgen" means the special unit of exposure. One roentgen (R) equals 2.58E-4 coulombs per kilogram of air (see "Exposure" and 001.15).

"Sealed source" means radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material .

"Shallow dose equivalent" (SDE) (H_s), which applies to the external exposure of the skin or an extremity, means the dose equivalent at a tissue depth of 0.007 centimeter ($7\text{mg}/\text{cm}^2$) averaged over an area of 1 square centimeter.

"SI" means the abbreviation for the International System of Units.

"Sievert" means the SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sievert is equal to the absorbed dose in gray multiplied by the quality factor (1 Sv = 100 rem).

"Source material" means:

- (1) Uranium or thorium, or any combination thereof, in any physical or chemical form; or
- (2) Ores which 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.

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"Source material milling" means any processing of ore, including underground solution extraction of unmined ore, primarily for the purpose of extracting or concentrating uranium or thorium therefrom and which results in the production of source material mill tailings.

"Sources of radiation" means any radioactive material, any radiation-generating equipment or any device or equipment emitting or capable of emitting radiation or radioactive material.

"Special form radioactive material" means radioactive material that satisfies the following conditions:

- (1) It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule;
- (2) The piece or capsule has at least one dimension not less than 5 millimeters (0.2 inch); and
- (3) It satisfies the test requirements specified by the U.S. Nuclear Regulatory Commission. A special form encapsulation designed in accordance with the U.S. Nuclear Regulatory Commission requirements in effect on June 30, 1983, and constructed prior to July 1, 1985, may continue to be used. A special form encapsulation either designed or constructed after June 30, 1985, must meet requirements of this definition applicable at the time of its design or construction.

"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 U.S. Nuclear Regulatory Commission, pursuant to the provisions of section 51 of the Atomic Energy Act of 1954, as amended, determines to be special nuclear material, but does not include source material; or
- (2) Any material artificially enriched by any material listed in part (1) of this definition, but does not include source material.

"Special nuclear material in quantities not sufficient to form a critical mass" means uranium enriched in the isotope U-235 in quantities not exceeding 350 grams of contained U-235; uranium-233 in quantities not exceeding 200 grams; plutonium in quantities not exceeding 200 grams; or any combination of them in accordance with the following formula: For each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified above for the same kind of special nuclear material. The sum of such ratios for all of the kinds of special nuclear material in combination shall not exceed 1. For example, the following quantities in combination would not exceed the limitation and are within the formula:

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

"Spent nuclear fuel" means irradiated nuclear fuel that has undergone at least one year of decay since being used as a source of energy in a power reactor. Spent nuclear fuel includes the special nuclear material, byproduct material, source material, and other radioactive material associated with fuel assemblies.

"Survey" means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of sources of radiation. When appropriate, such evaluation includes, but is not limited to, tests, physical examinations, and measurements of levels of radiation or concentrations of radioactive material present.

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"Test" means the process of verifying compliance with an applicable regulation.

"These regulations" mean all parts of Nebraska Regulations for Control of Radiation-Ionizing.

"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.

"Total organ dose equivalent" (TODE) means the sum of the deep dose equivalent and the committed dose equivalent to the organ receiving the highest dose as described in 004.51A6 of these regulations.

"Transuranic waste" means radioactive waste containing alpha-emitting transuranic elements, with radioactive half-lives greater than five years, in excess of one hundred nanocuries per gram.

"U.S. Department of Energy" means the Department of Energy established by Public Law 95-91, August 4, 1977, 91 Stat. 565, 42 U.S.C. 7101 *et seq.*, to the extent that the Department 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 (Public Law 93-438, October 11, 1974, 88 Stat. 1233 at 1237, 42 U.S.C. 5814, effective January 19, 1975) and retransferred to the Secretary of Energy pursuant to section 301(a) of the Department of Energy Organization Act (Public Law 95-91, August 4, 1977, 91 Stat. 565 at 577-578, 42 U.S.C. 7151, effective October 1, 1977.)

"Unrefined and unprocessed ore" means ore in its natural form prior to any processing, such as grinding, roasting, beneficiating, or refining.

"Unrestricted area" means an area, access to which is neither limited nor controlled by the licensee or registrant. For purposes of these regulations, "uncontrolled area" is an equivalent term.

"Violation" means an infringement of any rule, license or registration condition, order of the Agency, or any provision of the Act.

"Waste" means those low-level radioactive wastes that are acceptable for disposal in a management facility. For the purposes of this definition, low-level waste has the same meaning as in the Low-Level Radioactive Waste Policy Act, P.L. 96-573, as amended by P.L. 99-240, effective January 15, 1986; that is, radioactive waste (a) not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in Section 11e.(2) of the Atomic Energy Act (uranium or thorium tailings and waste) and (b) classified as low-level radioactive waste consistent with existing law and in accordance with (a) by the U.S. Nuclear Regulatory Commission.

"Waste handling licensees" mean persons licensed to receive and store radioactive wastes prior to disposal and/or persons licensed to dispose of radioactive waste .

"Week" means 7 consecutive days starting on Sunday.

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

"Worker" means an individual engaged in work under a license or registration issued by the Agency and controlled by a licensee or registrant, but does not include the licensee or registrant.

"Working level" (WL) means any combination of short-lived radon daughters in 1 liter of air that will result

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in the ultimate emission of $1.3E+5$ MeV of potential alpha particle energy. The short-lived radon daughters are -- for radon-222: polonium-218, lead-214, bismuth-214, and polonium-214; and for radon-220: polonium-216, lead-212, bismuth-212, and polonium-212.

"Working level month" (WLM) means an exposure to 1 working level for 170 hours -- 2,000 working hours per year divided by 12 months per year is approximately equal to 170 hours per month.

"Year" means the period of time beginning in January used to determine compliance with the provisions of these regulations. The licensee or registrant may change the starting date of the year used to determine compliance by the licensee or registrant provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.

001.03 Exemptions.

001.03A General Provision. The Agency may, upon application or upon its own initiative, grant such exemptions or exceptions from the requirements of these regulations as it determines are authorized by law and will not result in undue hazard to public health and safety or property.

001.03B U.S. Department of Energy Contractors and U.S. Nuclear Regulatory Commission Contractors. Any U.S. Department of Energy contractor or subcontractor and any U.S. Nuclear Regulatory Commission contractor or subcontractor of the following categories operating within this State is exempt from these regulations to the extent that such contractor or subcontractor under his contract receives, possesses, uses, transfers, or acquires sources of radiation:

001.03B1 Prime contractors performing work for the U.S. Department of Energy at U.S. Government-owned or -controlled sites, including the transportation of sources of radiation to or from such sites and the performance of contract services during temporary interruptions of such transportation;

001.03B2 Prime contractors of the U.S. Department of Energy performing research in, or development, manufacture, storage, testing, or transportation of, atomic weapons or components thereof;

001.03B3 Prime contractors of the U.S. Department of Energy using or operating nuclear reactors or other nuclear devices in a United States Government-owned vehicle or vessel; and

001.03B4 Any other prime contractor or subcontractor of the U.S. Department of Energy or of the U.S. Nuclear Regulatory Commission when the State and the U.S. Nuclear Regulatory Commission jointly determine:

001.03B4a That the exemption of the prime contractor or subcontractor is authorized by law; and

001.03B4b That, under the terms of the contract or subcontract, there is adequate assurance that the work thereunder can be accomplished without undue risk to the public health and safety.

001.04 Records. Each licensee and registrant shall maintain records showing the receipt, transfer, and disposal of all sources of radiation. Additional record requirements are specified elsewhere in these regulations.

001.05 Inspections.

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001.05A Each licensee and registrant shall afford the Agency at all reasonable times opportunity to inspect sources of radiation and the premises and facilities wherein such sources of radiation are used or stored.

001.05B Each licensee and registrant shall make available to the Agency for inspection upon

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001.11C Tests for leakage or contamination from sealed sources shall be performed by persons specifically authorized by the Agency, an Agreement State, or the U.S. Nuclear Regulatory Commission to perform such services.

001.11D Test results shall be kept in units of Becquerel or microcurie and maintained for inspection by the Agency.

001.11E The following shall be considered evidence that the sealed source is leaking:

001.11E1 The presence of 185 Bq (0.005 μ Ci) or more of removable contamination on any test sample.

001.11E2 Leakage of 37 Bq (0.001 μ Ci) of radon-222 per 24 hours for brachytherapy sources manufactured to contain radium.

001.11E3 The presence of removable contamination resulting from the decay of 185 Bq (0.005 μ Ci) or more of radium.

001.11F The licensee or registrant shall immediately withdraw a leaking sealed source from use and shall take action to prevent the spread of contamination. The leaking sealed source shall be repaired or disposed of in accordance with this Section.

001.11G Reports of test results for leaking or contaminated sealed sources shall be made pursuant to 004.63.

001.12 Communications. All communications and reports concerning these regulations, and applications filed thereunder, should be addressed to the Agency at its office located at

Department of Health and Human Services Regulation and Licensure
Public Health Assurance Division
301 Centennial Mall South
P.O. Box 95007
Lincoln, Nebraska 68509-5007

001.13 Reserved.

001.14 Discrimination Prohibited. No person shall on the ground of sex be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity licensed by this Agency. This provision will be enforced through provisions established, with respect to racial and other discrimination, under the Nebraska Fair Employment Act. This remedy is not exclusive, however, and will not prejudice or cut off any other legal remedies available to a discriminatee.

001.15 Units of Exposure and Dose.

001.15A As used in these regulations, the unit of exposure is the coulomb per kilogram (C/kg) of air. One roentgen is equal to 2.58E-4 coulomb per kilogram of air.

001.15B As used in these regulations, the units of dose are:

001.15B1 Gray (Gy) is the SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (100 rad).

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001.15B2 Rad is the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 erg per gram or 0.01 joule per kilogram (0.01 Gy).

001.15B3 Rem is the special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by the quality factor (1 rem = 0.01 Sv).

001.15B4 Sievert is the SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sievert is equal to the absorbed dose in gray multiplied by the quality factor (1 Sv = 100 rem).

001.15C As used in these regulations, the quality factors for converting absorbed dose to dose equivalent are shown in Table I.

TABLE I
QUALITY FACTORS AND ABSORBED DOSE EQUIVALENCIES

TYPE OF RADIATION	Quality Factor (Q)	Absorbed Dose Equal to a Unit Dose Equivalent ^a
X, gamma, or beta radiation and high-energy electrons	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

^aAbsorbed dose in gray equal to 1 Sv or the absorbed dose in rad equal to 1 rem.

001.15D 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 001.15C, 0.01 Sv (1 rem) of neutron radiation of unknown energies may, for purposes of these regulations, 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 or registrant may use the fluence rate per unit dose equivalent or the appropriate Q value from Table II to convert a measured tissue dose in gray or rad to dose equivalent in sievert or rem.

TABLE II

**MEAN QUALITY FACTORS, Q, AND FLUENCE PER UNIT DOSE
EQUIVALENT FOR MONOENERGETIC NEUTRONS**

	Neutron Energy (MeV)	Quality Factor ^a (Q)	Fluence per Unit Dose Equivalent ^b (neutrons cm ⁻² rem ⁻¹)	Fluence per Unit Dose Equivalent ^b (neutrons cm ⁻² sievert ⁻¹)
(thermal)	2.5E-8	2	980E+6	980E+8
	1E-7	2	980E+6	980E+8
	1E-6	2	810E+6	810E+8
	1E-5	2	810E+6	810E+8
	1E-4	2	840E+6	840E+8
	1E-3	2	980E+6	980E+8
	1E-2	2.5	1010E+6	1010E+8
	1E-1	7.5	170E+6	170E+8
	5E-1	11	39E+6	39E+8
	1	11	27E+6	27E+8
	2.5	9	29E+6	29E+8
	5	8	23E+6	23E+8
	7	7	24E+6	24E+8
	10	6.5	24E+6	24E+8
	14	7.5	17E+6	17E+8
	20	8	16E+6	16E+8
	40	7	14E+6	14E+8
	60	5.5	16E+6	16E+8
	1E+2	4	20E+6	20E+8
	2E+2	3.5	19E+6	19E+8
	3E+2	3.5	16E+6	16E+8
	4E+2	3.5	14E+6	14E+8

^aValue of quality factor (Q) at the point where the dose equivalent is maximum in a 30-centimeter diameter cylinder tissue-equivalent phantom.

^bMonoenergetic neutrons incident normally on a 30-centimeter diameter cylinder tissue-equivalent phantom.

001.16 Units of Activity. For the purposes of these regulations, activity is expressed in the SI unit of becquerel (Bq) or in the special unit of curie (Ci), or their multiples, or disintegrations or transformations per unit of time.

001.16A One becquerel (Bq) = 1 disintegration or transformation per second (dps or tps).

001.16B One curie = 3.7E+10 disintegrations or transformations per second (dps or tps) = 3.7E+10 becquerel (Bq) = 2.22E+12 disintegrations or transformations per minute (dpm or tpm).

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Section 002 REGISTRATION OF RADIATION GENERATING EQUIPMENT FACILITIES AND SERVICES

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002 REGISTRATION OF RADIATION GENERATION EQUIPMENT FACILITIES AND SERVICES

002.01 Purpose and Scope.

002.01A This section provides for the registration of radiation generating equipment facilities and for the registration of persons providing radiation generating equipment installation, servicing of radiation sources, radiation measurements and other services.

002.01B In addition to the requirements of this section, all registrants are subject to the applicable provisions of Sections 001, 004, 005, 006, 008, 009, 010, 015, 016, 017, and 018 of these regulations.

002.02 Definitions. For purposes of Section 002 of these regulations, "facility" means the location at which one or more devices or sources are installed and/or located within one building, vehicle, or under one roof and are under the same administrative control.

002.03 Exemptions.

002.03A Electronic equipment that produces radiation incidental to its operation for other purposes is exempt from the registration and notification requirements of this part, providing dose equivalent rate averaged over an area of 10 square centimeters does not exceed 0.5 mrem (5 μ Sv) per hour at 5 cm from any accessible surface of such equipment. The production, testing, or factory servicing of such equipment shall not be exempt.

002.03B Radiation generating equipment while in transit or storage incident thereto are exempt from the requirements of this part.

002.03C Domestic television receivers are exempt from the requirements of this part.

002.04 Application for Registration of Radiation Generating Equipment Facilities. Each person having a radiation generating equipment facility shall:

002.04A Apply for registration of such facility with the Agency within thirty (30) days following the commencement of the operation of a radiation generating equipment facility. Application for registration shall be completed on Form NRH-4 furnished by the Agency and shall contain all the information required by the form NRH-4 and accompanying instructions; and

002.04A1 Submit the appropriate fee as specified in Section 018 of these regulations.

002.04B Designate on the application form an individual to be responsible for radiation protection.

002.04C Each registrant shall prohibit any person from furnishing radiation generating equipment servicing or services as described in 002.05D to his radiation generating equipment facility until such person provides evidence that he has been registered with the Agency as a provider of services in accordance with 002.05. A list of these registrants shall be available for distribution by the Agency.

002.05 Application for Registration of Servicing and Services.

002.05A Each person who is engaged in the business of installing or offering to install radiation generating equipment or is engaged in the business of furnishing or offering to furnish radiation generating equipment servicing, radiation source servicing, radiation measurements, and/or other services in this State shall apply for registration of such services with the Agency within 30 days following January 1, 1974 or thereafter prior to furnishing or offering to furnish any such services.

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002.05B Application for registration shall be completed on form NRH-9 furnished by the Agency and shall contain all information required by the Agency as indicated on the forms and accompanying instructions; and

002.05B1 Submit the appropriate fee as specified in Section 018 of these regulations.

002.05C Each person applying for registration under this section shall specify:

002.05C1 That he has read and understands the requirements of these regulations; and

002.05C2 The services for which he is applying for registration; and

002.05C3 The training and experience that qualify him to discharge the services for which he is applying for registration. (See Section 015 of these regulations); and

002.05C4 The type of measurement instrument to be used, frequency of calibration, and calibration source; and

002.05C5 The type of personnel dosimeters supplied, frequency of reading, and replacement or exchange schedule.

002.05D For the purpose of 002.05, services may include but shall not be limited to:

002.05D1 Installation and/or servicing of radiation generating equipment and associated radiation generating equipment components. Services shall include those adjustments and measurements necessary for proper operation of radiation generating equipment. (See Subsection 015.33 of these regulations);

002.05D2 Calibration of radiation generating equipment or radiation measurement instruments or devices (See qualified expert training and experience qualifications in Subsection 015.13C of these regulations);

002.05D3 Radiation protection or health physics consultations, radiation measurements, or surveys (See qualified expert training and experience qualifications in Subsection 015.13C of these regulations);

002.05D4 Personnel dosimetry services. (See Subsection 015.34 of these regulations); and

002.05D5 Operation of radiation generating equipment by an individual (See Section 016 of these regulations).

002.05E No individual shall perform services which are not specifically stated for that individual on the certificate of registration issued by the Agency.

002.06 Issuance of Certificate of Registration (NRH-4 and/or NRH-9).

002.06A Upon a determination that an applicant meets the requirements of the regulations, the agency shall issue a Certificate of Registration.

002.06B The Agency may incorporate in the Certificate of Registration at the time of registration or thereafter by rule, regulation or order, such additional requirements and conditions with respect to the

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registrant's receipt, possession, use and transfer of radiation generating equipment, radiation source servicing, radiation measurements and/or services it deems appropriate or necessary.

002.07 Expiration of Certificate of Registration. Except as provided by 002.08(B), each certificate of registration shall expire annually on the anniversary of the date issued.

002.08 Renewal of Certificate of Registration.

002.08A Application for renewal of Registration shall be filed in accordance with 002.04 or 002.05.

002.08B In any case in which a registrant not less than 30 days prior to the expiration of his existing certificate of registration has filed an application in proper form for renewal, such existing certificate of registration shall not expire until the application status has been finally determined by the Agency.

002.09 Report of Changes. The registrant shall notify the Agency in writing within thirty (30) days of any change which would render the information contained in the application for registration no longer accurate.

002.10 Approval Not Implied. No person, in any advertisement, shall refer to the fact that he or his facility is registered with the Agency pursuant to the provisions of 002.04 or 002.05, and no person shall state or imply that any activity under such registration has been approved by the Agency.

002.11 Assembler and/or Transfer Obligation.¹

002.11A Any person who sells, leases, transfers, lends, disposes, assembles, or installs radiation generating equipment in this State shall notify the Agency within 15 days of:

002.11A1 The name and address of persons who have received this equipment;

002.11A2 The manufacturer, model, and serial number of each radiation generating equipment transferred; and

002.11A3 The date of transfer of each radiation generating equipment.

002.11B No person shall make, sell, lease, transfer, lend, assemble, or install radiation generating equipment or the components used in connection with such equipment unless such components and equipment when properly placed in operation and used shall meet the requirements of these regulations.

002.12 Out-of-State Radiation Generating Equipment.

002.12A Whenever any radiation generating equipment which is registered in another state or by the federal government is to be brought into the State, for any temporary use, the person proposing to bring such equipment into the State shall give written notice to the Agency (at least 2 working days) before such equipment is to be used in the State. The notice shall include:

¹In the case of diagnostic x-ray systems which contain certified components, a copy of the assembler's report (Form FDA 2579) prepared in compliance with requirements of 21 CFR Chapter 1, Section 1020.30(d) attached hereto as pages 466-468, except the stricken text of Attachment Number 3 and incorporated herein by this reference, shall suffice in lieu of any other report by the assembler.

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002.12A1 the type of radiation generating equipment;

002.12A2 the nature, duration, and scope of use; and

002.12A3 the exact location(s) where the radiation generating equipment is to be used; and

002.12A4 States in which this equipment is registered.

002.12B If, for a specific case, the (two working-day) period would impose an undue hardship on the person, upon application to the Agency, permission to proceed sooner may be granted.

002.12C The person referred to in 002.12A shall:

002.12C1 Comply with all applicable regulations of the Agency;

002.12C2 Supply the Agency with such other information as the Agency may reasonably request; and

002.12C3 Not operate within the State on a temporary basis in excess of 180 calendar days per year.

002.12C4 Submit the appropriate fee as specified in Section 018 of these regulations.

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Section 003 LICENSING OF RADIOACTIVE MATERIAL

003.01 Purpose and Scope.

003.01A This section provides for the licensing of radioactive material. No person shall receive, possess, use, transfer, own or acquire radioactive material except as authorized in a specific or general license issued pursuant to this section or as otherwise provided in this section.

003.01B In addition to the requirements of this section, all licensees are subject to the requirements of Section 001, Section 004, and Sections 010, 013, 015, 016, 017 and 018 of these regulations. Licensees engaged in industrial radiographic operations are subject to the requirements of Section 005, licensees using sealed sources in the healing arts are subject to the requirements of Section 007, licensees engaged in the management of radioactive waste are subject to the requirements of Section 012, licensees engaged in well logging and subsurface tracer studies are subject to the requirements of Section 014, and licensees using sealed sources containing radioactive materials in irradiators are subject to the requirements of Section 019.

003.02 Definitions. As used in this Section.

"Alert" means events may occur, are in progress, or have occurred that could lead to a release of radioactive material but that the release is not expected to require a response by offsite response organizations to protect persons offsite.

"Principal activities" means activities authorized by the license which are essential to achieving the purpose(s) for which the license was issued or amended. Storage during which no license material is accessed for use or disposal and activities incidental to decontamination or decommissioning are not principal activities.

"Site area emergency" means events may occur, are in progress, or have occurred that could lead to a significant release of radioactive material and that could require a response by offsite response organizations to protect persons offsite.

Exemptions

003.03 Source Material.

003.03A Any person is exempt from this section to the extent that such person receives, possesses, uses, owns, or transfers source material in any chemical mixture, compound, solution, or alloy in which the source material is by weight less than 1/20 of 1 percent (0.05 percent) of the mixture, compound, solution, or alloy.

003.03B Any person is exempt from this section to the extent that such person receives, possesses, uses, or transfers unrefined and unprocessed ore containing source material; provided that, except as authorized in a specific license, such person shall not refine or process such ore.

003.03C Any person is exempt from this section to the extent that such person receives, possesses, uses, or transfers:

003.03D Any person is exempt from this section to the extent that such person receives, possesses, uses, or transfers: [REDACTED]

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003.12 Special Requirements for Issuance of Certain Specific Licenses for Radioactive Material.

003.12A Reserved.

003.12B Reserved.

003.12C Reserved.

003.12D Reserved.

003.12E Reserved.

003.12F Reserved.

003.12G Reserved.

003.12H Reserved.

003.12I Use of Sealed Sources in Industrial Radiography. In addition to the requirements set forth in 003.11, a specific license for use of sealed sources in industrial radiography will be issued if:

003.1211 The applicant will have an adequate program for training radiographers and radiographer's assistants and submits to the Agency a schedule or description of such program which specifies the:

003.1211a Initial training,

003.1211b Periodic training,

003.1211c On-the-job training,

003.1211d Means to be used by the licensee to determine the radiographer's knowledge and understanding of, and the ability to comply with, Agency regulations and licensing requirements, and the operating and emergency procedures of the applicant, and

003.1211e Means to be used by the licensee to determine the radiographer's assistant's knowledge and understanding of and ability to comply with the operating and emergency procedures of the applicant;

003.1212 The applicant has established and submits to the Agency satisfactory written operating and emergency procedures described in 005.17 of these regulations;

003.1213 The applicant has established and submits to the Agency a description of its inspection program adequate to ensure that its radiographers and radiographers' assistants follow the Agency's regulatory requirements and the applicant's operating and emergency procedures. The inspection program must:

003.1213a Include observation of the performance of each radiographer and radiographer's assistant during an actual radiographic operation at intervals not to exceed three months;

003.1213b Provide that, if a radiographer or a radiographer's assistant has not participated in a radiographic operation for more than three months since the last inspection, that

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individual's performance must be observed and recorded the next time the individual participates in a radiographic operation; and

003.1213c Include the retention of inspection records on the performance of radiographers or radiographers' assistants for three years.

003.1214 The applicant submits to the Agency a description of the overall organizational structure pertaining to the industrial radiography program, including specified delegations of authority and responsibility for operation of the program;

003.1215 The applicant who desires to conduct his own leak tests has established adequate procedures to be followed in leak testing sealed sources for possible leakage and contamination and submits to the Agency a description of such procedures including:

003.1215a Instrumentation to be used,

003.1215b Method of performing tests, e.g., points on equipment to be smeared and method of taking smear, and

003.1215c Pertinent experience of the person who will perform the test; and

003.1216 The licensee shall conduct a program for inspection and maintenance of radiographic exposure devices and storage containers to assure proper functioning of components important to safety.

003.1217 The applicant submits documentation of the training and experience requirements for use of sealed radioactive sources consistent with training specified in Section 015 of these regulations:

003.1217a Individual user(s), or

003.1217b The individual(s) conducting the training program.

003.13 Special Requirements for Specific Licenses of Broad Scope. This subsection prescribes requirements for the issuance of specific licenses of broad scope for radioactive material ("broad licenses") and certain regulations governing holders of such licenses.

003.13A The different types of broad licenses are set forth below:

003.13A1 A "Type A specific license of broad scope" is a specific license authorizing receipt, acquisition, ownership, possession, use and transfer of any chemical or physical form of the radioactive material specified in the license, but not exceeding quantities specified in the license, for any authorized purpose. The quantities specified are usually in the multicurie range, and the limits are based on types of radioactive materials, proposed use and upon the training and experience of the user(s).

003.13A2 A "Type B specific license of broad scope" is a specific license authorizing receipt, acquisition, ownership, possession, use and transfer of any chemical or physical form of radioactive material specified in Appendix 003-C, of this section for any authorized purpose. The possession limit for a Type B broad license, if only one radionuclide is possessed thereunder, is the quantity specified for that radionuclide in Appendix 003-C, Column I of this section. If two or more radionuclides are possessed thereunder, the possession limit for each is determined as follows: For each radionuclide, determine the ratio of the quantity possessed to the applicable

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quantity specified in Appendix 003-C, Column I of this section, for that radionuclide. The sum of the ratios for all radionuclides possessed under the license shall not exceed unity.

003.13A3 A "Type C specific license of broad scope" is a specific license authorizing receipt, acquisition, ownership, possession, use and transfer of any chemical or physical form of radioactive material specified in Appendix 003-C, of this section for any authorized purpose. The possession limit for a Type C broad license, if only one radionuclide is possessed thereunder, is the quantity specified for that radionuclide in Appendix 003-C, Column II of this section. If two or more radionuclides are possessed thereunder, the possession limit is determined for each as follows: For each radionuclide determine the ratio of the quantity possessed to the applicable quantity specified in Appendix 003-C, Column II of this section, for that radionuclide. The sum of the ratios for all radionuclides possessed under the license shall not exceed unity.

003.13B An application for a Type A specific license of broad scope will be approved if:

003.13B1 The applicant satisfies the general requirements specified in 003.11;

003.13B2 The applicant has engaged in a reasonable number of activities involving the use of radioactive material; and

003.13B3 The applicant has established administrative controls and provisions relating to organization and management, procedures, record keeping, material control and accounting, and management review that are necessary to assure safe operations, including:

003.13B3a The establishment of a radiation safety committee composed of such persons as a radiation safety officer, a representative of management, and persons trained and experienced in the safe use of radioactive material;

003.13B3b The appointment of a radiation safety officer who is qualified in training and experience in radiation protection consistent with the requirements of training specified in Subpart 015.15A1 of these regulations and who is available for advice and assistance on radiation safety matters; and

003.13B3c Authorized users designated by the Radiation Safety Committee shall have formal training and experience in the safe handling of radioactive material consistent with the requirements of training specified in Subpart 015.15A2 of these regulations; and

003.13B3d The establishment of appropriate administrative procedures to assure:

003.13B3d(1) Control of procurement and use of radioactive material;

003.13B3d(2) Completion of safety evaluations of proposed uses of radioactive material which takes into consideration such matters as the adequacy of facilities and equipment, training and experience of the user, and the operating or handling procedures; and

003.13B3d(3) Review, approval, and recording by the radiation safety committee of safety evaluations of proposed uses prepared in accordance with 003.13B3d(2) prior to use of the radioactive material.

003.13C An application for a Type B specific license of broad scope will be approved if:

003.13C1 The applicant satisfies the general requirements specified in 003.11; and

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003.13C2 The applicant has established administrative controls and provisions relating to organization and management, procedures, record keeping, material control and accounting, and management review that are necessary to assure safe operations, including:

003.13C2a The appointment of a radiation safety officer who is qualified by training and experience in radiation protection consistent with the requirements of training specified in Subpart 015.15A1 of these regulations and who is available for advice and assistance on radiation safety matters,

003.13C2b Authorized users shall have formal training and experience in the safe handling of radioactive material consistent with the requirements of training specified in Subpart 015.15A2 of these regulations; and

003.13C2c The establishment of appropriate administrative procedures to assure:

003.13C2c(1) Control of procurement and use of radioactive material,

003.13C2c(2) Completion of safety evaluations of proposed uses of radioactive material which take into consideration such matters as the adequacy of facilities and equipment, training and experience of the user, and the operating or handling procedures, and

003.13C2c(3) Review, approval, and recording by the radiation safety officer of safety evaluations of proposed uses prepared in accordance with 003.13C2c(2) prior to use of the radioactive material.

003.13D An application for a Type C specific license of broad scope will be approved if:

003.13D1 The applicant satisfies the general requirements specified in 003.11;

003.13D2 The applicant submits a statement that radioactive material will be used only by, or under the direct supervision of, individuals who have received:

003.13D2a A college degree at the bachelor level, or equivalent training and experience, in the physical or biological sciences or in engineering, and

003.13D2b At least 40 hours of formal training and 160 hours experience in the safe handling of radioactive material, and in the characteristics of ionizing radiation, units of radiation dose and quantities, radiation detection instrumentation, and biological hazards of exposure to radiation appropriate to the type and forms of radioactive material to be used; and

003.13D3 The applicant has established administrative controls and provisions relating to procurement of radioactive material, procedures, record keeping, material control and accounting, and management review necessary to assure safe operations.

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003.14E2 The applicant satisfies the requirements of 10 CFR Chapter I, Part 30, Section 30.33, attached hereto as Attachment Number 10 and Part 32, Sections 32.53-32.56 and 32.101 except stricken text attached hereto as part of Attachment Number 4 and incorporated herein by this reference or their equivalent, and

003.14E3 The Radiation Safety Officer and/or authorized user shall have training and experience requirements consistent with training specified in Part 015.18A of these regulations.

003.14F Special Requirements for License to Manufacture Calibration Sources Containing Americium-241, Plutonium or Radium-226 for Distribution to Persons Generally Licensed Under 003.08G. An application for a specific license to manufacture calibration and reference sources containing americium-241, plutonium or radium-226 to persons generally licensed under 003.08G will be approved subject to the following conditions:

003.14F1 The applicant satisfies the general requirement of 003.11, and

003.14F2 The applicant satisfies the requirements of 10 CFR Chapter I, Part 30, Section 30.33 attached hereto as Attachment Number 10 and Part 32, Sections 32.57-32.59 and 32.102 attached hereto as part of Attachment Number 4 and 10 CFR Chapter I, Part 70, Section 70.39 as part of Attachment Number 5 herein and incorporated herein by this reference or their equivalent, and

003.14F3 The Radiation Safety Officer and/or authorized user shall have training and experience requirements consistent with training specified in Part 015.18A of these regulations.

003.14G Reserved.

003.14H Manufacture and Distribution of Radioactive Material for Certain In Vitro Clinical or Laboratory Testing Under General License. An application for a specific license to manufacture or distribute radioactive material for use under the general license of 003.081 will be approved if:

003.14H1 The applicant satisfies the general requirements specified in 003.11.

003.14H2 The radioactive material is to be prepared for distribution in prepackaged units of:

003.14H2a Iodine-125 in units not exceeding 370 kBq (10 microcuries) each.

003.14H2b Iodine-131 in units not exceeding 370 kBq (10 microcuries) each.

003.14H2c Carbon-14 in units not exceeding 370 kBq (10 microcuries) each.

003.14H2d Hydrogen-3 (tritium) in units not exceeding 1.85 MBq (50 microcuries) each.

003.14H2e Iron-59 in units not exceeding 740 kBq (20 microcuries) each.

003.14H2f Cobalt-57 in units not exceeding 370 kBq (10 microcuries) each.

003.14H2g Selenium-75 in units not exceeding 370 kBq (10 microcuries) each.

003.14H2h Mock Iodine-125 in units not exceeding 1.85 kBq (0.05 microcurie) of iodine-129 and 185 Bq (0.005 microcurie) of americium-241 each.

003.14H3 Each prepackaged unit bears a durable, clearly visible label:

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003.14H3a Identifying the radioactive contents as to chemical form and radionuclide, and indicating that the amount of radioactivity does not exceed 370 kBq (10 microcuries) of iodine-125, iodine-131, carbon-14, cobalt-57, or selenium-75; 1.85 MBq (50 microcuries) of hydrogen-3 (tritium); 740 kBq (20 microcuries) of iron-59; or Mock Iodine-125 in units not exceeding 1.85 kBq (0.05 microcurie) of iodine-129 and 185 Bq (0.005 microcurie) of americium-241 each; and

003.14H3b Displaying the radiation caution symbol described in 004.32A and the words, "CAUTION, RADIOACTIVE MATERIAL" and "Not for Internal or External Use in Humans or Animals."

003.14H4 The following statement, or a substantially similar statement which contains the information called for in the following statement, appears on a label affixed to each prepackaged unit or appears in a leaflet or brochure which accompanies the package:

This radioactive material may be received, acquired, possessed, and used only by physicians, veterinarians in the practice of veterinary medicine, clinical laboratories or hospitals and only for In Vitro clinical or laboratory tests not involving internal or external administration of the material, or the radiation therefrom, to human beings or animals. Its receipt, acquisition, possession, use, and transfer are subject to the regulations and a general license of the U.S. Nuclear Regulatory Commission or of a State with which the Commission has entered into an agreement for the exercise of regulatory authority.

Name of Manufacturer

003.14H5 The label affixed to the unit, or the leaflet or brochure which accompanies the package, contains adequate information as to the precautions to be observed in handling and storing such radioactive material. In the case of Mock Iodine-125 reference or calibration source, the information accompanying the source must also contain directions to the licensee regarding the waste disposal requirements set out in 004.38 of these regulations.

003.14H6 The Radiation Safety Officer and/or authorized user shall have training and experience requirements consistent with training specified in Part 015.19A of these regulations.

003.14I Licensing the Manufacture and Distribution of Ice Detection Devices. An application for a specific license to manufacture and distribute ice detection devices to persons generally licensed under 003.08J will be approved subject to the following conditions: (1) the applicant satisfies the general requirements of 003.11 and (2) the criteria of 10 CFR Chapter I, Part 30, Section 30.33, attached hereto as Attachment Number 10 and Part 32, Sections 32.61, 32.62, 32.103 as attached hereto as part of Attachment Number 4 and incorporated herein by this reference are met.

003.14I1 The Radiation Safety Officer and/or authorized user shall have training and experience requirements consistent with training specified in Part 015.18A of these regulations.

003.14J Manufacture, Preparation, or Transfer for Commercial Distribution of Radioactive Drugs Containing Radioactive Material for Medical Use Under Section 007 of These Regulations.

003.14J1 An application for a specific license to manufacture, prepare, or transfer for commercial distribution radioactive drugs containing radioactive material for use by persons authorized pursuant to Section 007 of these regulations, will be approved if:

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003.14J1a The applicant satisfies the general requirements specified in 003.11;

003.14J1b The applicant submits evidence that the applicant is at least one of the following:

003.14J1b(1) Registered or licensed with the U.S. Food and Drug Administration (FDA) as a drug manufacturer;

003.14J1b(2) Registered or licensed with a state agency as a drug manufacturer;

003.14J1b(3) Licensed as a pharmacy by a State Board of Pharmacy; or

003.14J1b(4) Operating as a nuclear pharmacy within a Federal medical institution.

003.14J1c The applicant submits information on the radionuclide; the chemical and physical form; the maximum activity per vial, syringe, generator, or other container of the radioactive drug; and the shielding provided by the packaging to show it is appropriate for the safe handling and storage of the radioactive drugs by medical use licensees; and

003.14J1d The applicant satisfies the following labeling requirements:

003.14J1d(1) A label is affixed to each transport radiation shield, whether it is constructed of lead, glass, plastic, or other material, of a radioactive drug to be transferred for commercial distribution. The label must include the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL"; the name of the radioactive drug or its abbreviation; and the quantity of radioactivity at a specified date and time. For radioactive drugs with a half life greater than 100 days, the time may be omitted.

003.14J1d(2) A label is affixed to each syringe, vial or other container used to hold a radioactive drug to be transferred for commercial distribution. The label must include the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL" and an identifier that ensures that the syringe, vial, or other container can be correlated with the information on the transport radiation shield label.

003.14J2 A licensee described by 003.14J1b(3) or (4):

003.14J2a May prepare radioactive drugs for medical use, as defined in Subsection 007.02 of these regulations, provided that the radioactive drug is prepared by either an authorized nuclear pharmacist, as specified in 003.13J2b and c of this Section, or an individual under the supervision of an authorized nuclear pharmacist as specified in Subsection 007.13.

003.14J2b May allow a pharmacist to work as an authorized nuclear pharmacist if:

003.14J2b(1) This individual qualifies as an authorized nuclear pharmacist as defined in Subsection 007.02 of these regulations;

003.14J2b(2) This individual meets the requirements specified in Part 007.66O and Subsection 007.66L and the licensee has received an approved license amendment identifying this individual as an authorized nuclear pharmacist, or

003.14J2b(3) This individual is designated as an authorized nuclear pharmacist in accordance with 003.14J2c.

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003.14J2c The actions authorized in 003.14J2a and b are permitted in spite of more restrictive language in license conditions.

003.14J2d May designate a pharmacist (as defined in Subsection 007.02) as an authorized nuclear pharmacist if the individual is identified as of the effective date of these regulations, as an "authorized user" on a nuclear pharmacy license issued by the Agency under this Section.

003.14J2e Shall provide to the Agency a copy of each individual's certification by the Board of Pharmaceutical Specialties, the Agency, U.S. Nuclear Regulatory Commission, or any Agreement State license, or the permit issued by a licensee of broad scope, and a copy of the state pharmacy licensure or registration, no later than 30 days after the date that the licensee allows, pursuant to 003.14J2b(1) and (3), the individual to work as an authorized nuclear pharmacist.

003.14J3 A licensee shall possess and use instrumentation to measure the radioactivity of radioactive drugs. The licensee shall have procedures for use of the instrumentation. The licensee shall measure, by direct measurement or by combination of measurements and calculations, the amount of radioactivity in dosages of alpha-, beta-, or photon-emitting radioactive drugs prior to transfer for commercial distribution. In addition, the licensee shall:

003.14J3a Perform tests before initial use, periodically, and following repair, on each instrument for accuracy, linearity, and geometry dependence, as appropriate for the use of the instrument; and make adjustments when necessary; and

003.14J3b Check each instrument for constancy and proper operation at the beginning of each day of use.

003.14J4 Nothing in this Part relieves the licensee from complying with applicable FDA, other Federal, and State requirements governing radioactive drugs.

003.14K Reserved

003.14L Manufacture and Distribution of Sources or Devices Containing Radioactive Material for Medical Use. An application for a specific license to manufacture and distribute sources and devices containing radioactive material to persons licensed pursuant to Section 007 for use as a calibration or reference source or for the uses listed in Subsections 007.44 and 007.46 of these regulations will be approved if:

003.14L1 The applicant satisfies the general requirements in 003.11 of this section.

003.14L2 The applicant submits sufficient information regarding each type of source or device pertinent to an evaluation of its radiation safety, including:

003.14L2a The radioactive material contained, its chemical and physical form, and amount,

003.14L2b Details of design and construction of the source or device,

003.14L2c Procedures for, and results of, prototype tests to demonstrate that the source or device will maintain its integrity under stresses likely to be encountered in normal use and

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003.17E Each licensee shall notify the Agency in writing immediately following the filing of a voluntary or involuntary petition for bankruptcy under any Chapter of Title 11 (Bankruptcy) of the United States Code by or against:

003.17E1 The licensee;

003.17E2 An entity (as that term is defined in 11 U.S.C. 101(14)) attached hereto as Attachment Number 7 and incorporated herein by this reference controlling the licensee or listing the license or licensee as property of the estate; or

003.17E3 An affiliate (as that term is defined in 11 U.S.C. 101(2)) attached hereto as Attachment Number 7 and incorporated herein by this reference of the licensee.

003.17E4 This notification must indicate:

003.17E4a The bankruptcy court in which the petition for bankruptcy was filed; and

003.17E4b The date of the filing of the petition.

003.18 Financial Assurance and Recordkeeping for Decommissioning.

003.18A Each applicant for a specific license authorizing the possession and use of unsealed byproduct material of half-life greater than 120 days and in quantities exceeding 10^5 times the applicable quantities set forth in Appendix 004-F of Part 004 of these regulations shall submit a decommissioning funding plan as described in 003.18E. The decommissioning funding plan must also be submitted when a combination of isotopes is involved if R divided by 10^5 is greater than 1 (unity rule), where R is defined here as the sum of the ratios of the quantity of each isotope to the applicable value in Appendix 004-F of Section 004.

003.18B Each applicant for a specific license authorizing possession and use of byproduct material of half-life greater than 120 days and in quantities specified in 003.18D shall either—

003.18B1 Submit a decommissioning funding plan as described in 003.18E or

003.18B2 Submit a certification that financial assurance for decommissioning has been provided in the amount prescribed by 003.18D using one of the methods described in 003.18F. For an applicant, this certification may state that the appropriate assurance will be obtained after the application has been approved and the license issued but prior to the receipt of radioactive material. If the applicant defers execution of the financial instrument until after the license has been issued, a signed original of the financial instrument obtained to satisfy 003.18F must be submitted to the Agency before receipt of radioactive material. If the applicant does not defer execution of the financial instrument, the applicant shall submit to the Agency as part of the certification, a signed original of the financial instrument obtained to satisfy the requirements of 003.18F.

003.18C Each holder of a specific license:

003.18C1 Issued on or after May 30, 1994 and of a type described in 003.18A or 003.18B, shall provide financial assurance for decommissioning in accordance with the criteria set for this subsection.

003.18C2 Issued before May 30, 1994, and of a type described in 003.18A shall submit, on or before May 30, 1994, a decommissioning funding plan or a certification of financial assurance for decommissioning in an amount at least equal to \$750,000 in accordance with the criteria set forth

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in this subsection. If the licensee submits the certification of financial assurance rather than a decommissioning funding plan, the licensee shall include a decommissioning funding plan in any application for license renewal.

003.18C3 Issued before May 30, 1994, and of a type described in 003.18B shall submit, on or before May 30, 1994, a certification of financial assurance for decommissioning in accordance with the criteria set forth in this subsection.

003.18D Table of required amounts of financial assurance for decommissioning by quantity of material.

greater than 10^4 but less than or equal to 10^5 times the applicable quantities of Appendix 004-F of Section 004 of these regulations in unsealed form. (For a combination of isotopes, if R, as defined in part 003.18A, divided by 10^4 is greater than 1 but R divided by 10^5 is less than or equal to 1.)

\$750,000

greater than 10^3 but less than or equal to 10^4 times the applicable quantities of Appendix 004-F of Section 004 of these regulations in unsealed form. (For a combination of isotopes, if R, as defined in part 003.18A, divided by 10^3 is greater than 1 but R divided by 10^4 is less than or equal to 1.)

\$150,000

greater than 10^{10} times the applicable quantities of Appendix 004-F of Section 004 of these regulations in sealed sources or plated foils. (For a combination of isotopes, if R, as defined in 003.18A, divided by 10^{10} is greater than 1.)

\$75,000

003.18E Each decommissioning funding plan must contain a cost estimate for decommissioning and a description of the method of assuring funds for decommissioning from part 003.18F, including means of adjusting cost estimates and associated funding levels periodically over the life of the facility. The decommissioning funding plan must also contain a certification by the licensee that financial assurance for decommissioning has been provided in the amount of the cost estimate for decommissioning and a signed original of the financial statement obtained to satisfy the requirements of 003.18F.

003.18F Financial assurance for decommissioning must be provided by one or more of the following methods:

003.18F1 Prepayment. Prepayment is the deposit prior to the start of operation into an account segregated from licensee assets and outside the licensee's administrative control of cash or liquid assets such that the amount of funds would be sufficient to pay decommissioning costs. Prepayment may be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities.

003.18F2 A surety method, insurance, or other guarantee method. These methods guarantee that decommissioning costs will be paid. A surety method may be in the form of a surety bond, letter of credit, or line of credit. A parent company guarantee of funds for decommissioning costs

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based on a financial test may be used if the guarantee and test are as contained in Appendix 003-A of this section. A parent company guarantee may not be used in combination with other financial methods to satisfy the requirements of this subsection. A guarantee of funds by the applicant or licensee for decommissioning based on a financial test may be used if the guarantee and test are as contained in Appendix 003-D of this section. A guarantee by the applicant or licensee may not be used in combination with any other financial methods to satisfy the requirements of this subsection or in any situation where the applicant or licensee has a parent company holding majority control of the voting stock of the company. Any surety method or insurance used to provide financial assurance for decommissioning must contain the following conditions:

003.18F2a The surety method or insurance must be open-ended or, if written for a specified term, such as five years, must be renewed automatically unless 90 days or more prior to the renewal date, the issuer notifies the Agency, the beneficiary, and the licensee of its intention not to renew. The surety method or insurance must also provide that the full face amount be paid to the beneficiary automatically prior to the expiration without proof of forfeiture if the licensee fails to provide a replacement acceptable to the Agency within 30 days after receipt of notification of cancellation.

003.18F2b The surety method or insurance must be payable to a trust established for decommissioning costs. The trustee and trust must be acceptable to the Agency. An acceptable trustee includes an appropriate State or Federal government agency or an entity which has the authority to act as a trustee and whose trust operations are regulated and examined by a Federal or State agency.

003.18F2c The surety method or insurance must remain in effect until the Agency has terminated the license.

003.18F3 An external sinking fund in which deposits are made at least annually, coupled with a surety method or insurance, the value of which may decrease by the amount being accumulated in the sinking fund. An external sinking fund is a fund established and maintained by setting aside funds periodically in an account segregated from licensee assets and outside the licensee's administrative control in which the total amount of funds would be sufficient to pay decommissioning costs at the time termination of operation is expected. An external sinking fund may be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities. The surety or insurance provisions must be as stated in subpart 003.18F2.

003.18F4 In the case of Federal, State, or local government licensees, a statement of intent containing a cost estimate for decommissioning or an amount based on the Table in part 003.18D, and indicating that funds for decommissioning will be obtained when necessary.

003.18G Each person licensed under Sections 003, 005, 007, 014, and 019 shall keep records of information important to the decommissioning of the facility in an identified location until the site is released for unrestricted use. Before licensed activities are transferred or assigned in accordance with Subsection 003.17B, licensees shall transfer all records described in this part to the new licensee. In this case, the new licensee will be responsible for maintaining these records until the license is terminated. If records important to the decommissioning of a facility are kept for other purposes, reference to these records and their locations may be used. Information the Agency considers important to decommissioning consists of:

003.18G1 Records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site. These records may be limited to instances when contamination remains after any cleanup procedures or when there is reasonable likelihood that

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contaminants may have spread to inaccessible areas as in the case of possible seepage into porous materials such as concrete. These records must include any known information on identification of involved nuclides, quantities, forms, and concentrations.

003.18G2 As-built drawings and modifications of structures and equipment in restricted areas where radioactive materials are used and/or stored and of locations of possible inaccessible contamination such as buried pipes which may be subject to contamination. If required drawings are referenced, each relevant document need not be indexed individually. If drawings are not available, the licensee shall substitute appropriate records of available information concerning these areas and locations.

003.18G3 Except for areas containing only sealed sources (provided the sources have not leaked or no contamination remains after any leak) or byproduct materials having only half-lives of less than 65 days, a list contained in a single document and updated every 2 years, of the following:

003.18G3a All areas designated and formerly designated as restricted areas as defined under 001.02 of these regulations;

003.18G3b All areas outside of restricted areas that require documentation under 003.18G1;

003.18G3c All areas outside of restricted areas where current and previous wastes have been buried as documented under 004.53 of these regulations; and

003.18G3d All areas outside of restricted areas which contain material such that, if the license expired, the licensee would be required to either decontaminate the area to unrestricted release levels or apply for approval for disposal under 004.39 of these regulations

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003.26C1d The isotopes, quantities, and chemical and physical form of the radioactive material involved; and

003.26C1e Any personnel radiation exposure data available.

003.26C2 Written report. Each licensee who makes a report required by Parts 003.26A or B shall submit a written follow-up report within 30 days of the initial report. Written reports prepared pursuant to other regulations may be submitted to fulfill this requirement if the reports contain all of the necessary information and the appropriate distribution is made. These written reports must be sent to:

Department of Health and Human Services Regulation and Licensure
Public Health Assurance Division
301 Centennial Mall South
P.O. Box 95007
Lincoln, NE 68509-5007

The reports must include the following:

003.26C2a A description of the event, including the probable cause and the manufacturer and model number, if applicable, of any equipment that failed or malfunctioned;

003.26C2b The exact location of the event;

003.26C2c The isotopes, quantities, and chemical and physical form of the radioactive material involved;

003.26C2d Date and time of the event;

003.26C2e Corrective actions taken or planned and the results of any evaluations or assessments; and

003.26C2f The extent of exposure of individuals to radiation or to radioactive materials without identification of individuals by name.

003.27 Modification and Revocation of Licenses. The terms and conditions of all licenses shall be subject to amendment, revision, modification, limitation, suspension or revocation upon:

003.27A Amendments to the Radiation Control Act or the rules and regulations adopted pursuant thereto;

003.27B Voluntary application for license amendment, revision, modification, limitation, suspension or surrender made by the licensee;

003.27C Disciplinary action pursuant to Section 017 of these regulations; or

003.27D Pursuant to emergency order as provided by Section 71-3513(6) of the Act.

Reciprocity

003.28 Reciprocal Recognition of Licenses.

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003.28A Licenses of Radioactive Material except Special Nuclear Material in Quantities Sufficient to Form a Critical Mass.

003.28A1 Subject to these regulations, any person who holds a specific license from the U.S. Nuclear Regulatory Commission or any Agreement State, and issued by the Agency having jurisdiction where the licensee maintains an office for directing the licensed activity and at which radiation safety records are normally maintained, is hereby granted a general license to conduct the activities authorized in such licensing document within this State for a period not in excess of 180 days in any calendar year provided that:

003.28A1a The licensing document does not limit the activity authorized by such document to specified installations or locations;

003.28A1b The out-of-state licensee notifies the Agency in writing at least three (3) days prior to engaging in such activity. Such notification shall include:

003.28A1b(1) Name of company for whom services will be performed, an individual to be contacted representing the company and telephone number.

003.28A1b(2) The exact location, start date, duration, and type of activity to be conducted.

003.28A1b(3) The name(s), documentation of training, and in-state address(es) of the individual(s) performing the activity,

003.28A1b(4) The identification of the sources of radiation to be used,

003.28A1b(5) A copy of the pertinent license,

003.28A1b(6) A copy of the licensee's operating and emergency procedures, and

003.28A1b(7) An annual fee as specified in Section 018 of these regulations.

003.28A1b(8) The out-of-state licensee notifies the Agency of changes in work locations, radioactive material, or work activities different from the information contained on the initial notification.

If, for a specific case, the three (3) day period would impose an undue hardship on the out-of-state licensee, the licensee may, upon application to the Agency, obtain permission to proceed sooner. The Agency may waive the requirement for filing additional written notifications during the remainder of the calendar year following the receipt of the initial notification from a person engaging in activities under the general license provided in 003.28A1.

003.28A1c The out-of-state licensee complies with all applicable regulations of the Agency and with all the terms and conditions of the licensing document, except any such terms and conditions which may be inconsistent with applicable regulations of the Agency;

003.28A1d The out-of-state licensee maintains a current copy of the appropriate license, and all amendments thereto, issued by the Agency;

003.28A1e The out-of-state licensee supplies such other information as the Agency may request;

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003.28A1f The out-of-state licensee shall not transfer or dispose of radioactive material possessed or used under the general license provided in 003.28A1 except by transfer to a person:

003.28A1f(1) Specifically licensed by the Agency or by the U.S. Nuclear Regulatory Commission to receive such material, or

003.28A1f(2) Exempt from the requirements for a license for such material under 003.04A.

003.28A2 Notwithstanding the provisions of 003.28A1 any person who holds a specific license issued by the U.S. Nuclear Regulatory Commission or an Agreement State authorizing the holder to manufacture, transfer, install, or service a device described in 003.08D1 within areas subject to the jurisdiction of the licensing body is hereby granted a general license to install, transfer, demonstrate or service such a device in this State provided that:

003.28A2a Such person shall file a report with the Agency within thirty (30) days after the end of each calendar quarter in which any device is transferred to or installed in this State. Each such report shall identify each general licensee to whom such device is transferred by name and address, the type and model of device transferred, and the quantity and type of radioactive material contained in the device;

003.28A2b The device has been manufactured, labeled, installed, and serviced in accordance with applicable provisions of the specific license issued to such person by the U.S. Nuclear Regulatory Commission or an Agreement State;

003.28A2c Such person shall assure that any labels required to be affixed to the device under regulations of the authority which licensed manufacture of the device bear a statement that "Removal of this label is prohibited"; and

003.28A2d The holder of the specific license shall furnish to each general licensee to whom he transfers such device or on whose premises he installs such device a copy of the general license contained in 003.08D.

003.28A3 The Agency may withdraw, limit, or qualify its acceptance of any specific license or equivalent licensing document issued by another agency, or any product distributed pursuant to such licensing document, upon determining that such action is necessary in order to achieve compliance with these regulations or to prevent undue hazard to public health and safety or property.

003.28A4 Before radioactive materials can be used at a temporary job site within the State at any Federal facility, the jurisdictional status of the job site must be determined. If the jurisdictional status is unknown, the Federal agency should be contacted to determine if the job site is under exclusive Federal jurisdiction.

003.28A4a In areas of exclusive Federal jurisdiction, the general license is subject to all the applicable rules, regulations, orders and fees of the U.S. Nuclear Regulatory Commission, and

003.28A4b Authorizations for use of radioactive materials at job sites under exclusive Federal jurisdiction shall be obtained from the U.S. Nuclear Regulatory Commission by either (1) filing a NRC Form-241 in accordance with 10 CFR 150.20(b); or (2) by applying for a specific U.S. Nuclear Regulatory Commission license.

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003.28A5 Before radioactive material can be used at a temporary job site in another State, authorization shall be obtained for the State if it is an Agreement State, or from the U.S. Nuclear Regulatory Commission for any non-Agreement State, either by filing for reciprocity or applying for a specific license.

003.29 Reserved.

003.30 Records.

003.30A Each person who receives radioactive material pursuant to a license issued pursuant to Sections 003, 005, 007, 012, 014, and 019 shall keep records showing the receipt, use, transfer, and disposal of such radioactive material.

003.30B Records which are required pursuant to part 003.30A shall be maintained for the period specified by the appropriate regulation. If a retention period is not otherwise specified by regulation such records shall be maintained for a period of one year after the records of the licensee have been inspected by the Agency unless any litigation, claim, negotiation, audit, licensure action, or other action involving the records has been initiated before the expiration of the one-year period, in which case the records must be retained until the completion of the action and resolution of all issues, or until the end of the regular one-year period, whichever is later.

003.30C Records of receipt of radioactive material which must be maintained pursuant to part 003.29A will be maintained as long as the licensee retains possession of the radioactive material and for five years following transfer, or disposition of the radioactive material and;

003.30C1 Records of transfer of radioactive material shall be maintained by the licensee who transferred the material until the Agency authorizes their disposition and;

003.30C2 Records of disposal of radioactive material shall be maintained in accordance with 004.53.

003.30C3 If radioactive material is combined or mixed with other licensed material and subsequently treated in a manner which makes direct correlation of a receipt record with a transfer, export, or disposition record impossible, evaluative techniques such as first-in-first-out may be used for purposes of the records retention requirements of this subpart.

003.30D Records which must be maintained pursuant to part 003.30A may be the original or reproduced copy of 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 Agency regulations. The record may also be stored in electronic media with the capability for producing legible, accurate and complete record during the required retention period. Records such as letters, drawing, 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.

003.30E If there is a conflict between the Agency's regulations in this part, license condition, or other written Agency 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 Agency pursuant to 001.03A has granted a specific exemption from the record retention requirements specified in the regulations in this part.

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003.30F Prior to license termination, each licensee authorized to possess radioactive material with a half-life greater than 120 days, in an unsealed form, shall forward the following records to the Agency:

003.30F1 Records of disposal of licensed material made under Subsections, 004.39, 004.40, 004.41, 004.42; and

003.30F2 Records required by Subpart 004.47B4

003.30G If licensed activities are transferred or assigned in accordance with 003.17B, each licensee authorized to possess radioactive material with a half-life greater than 120 days, in an unsealed form, shall transfer the following records to the new licensee and the new licensee will be responsible for maintaining these records until the license is terminated:

003.30G1 Records of disposal of licensed material made under Subsections, 004.39, 004.40, 004.41, 004.42; and

003.30G2 Records required by Subpart 004.47B4.

003.30H Prior to license termination, each licensee shall forward the records required by 003.18G to the Agency.

APPENDIX 003-A

EXEMPT CONCENTRATIONS

Element (atomic number)	Isotope	Column I Gas Concentration $\mu\text{Ci/ml}^*$	Column II Liquid and Solid Concentration $\mu\text{Ci/ml}^{**}$
Antimony (51)	Sb-122		3E-4
	Sb-124		2E-4
	Sb-125		1E-3
Argon (18)	Ar-37	1E-3	
	Ar-41	4E-7	
Arsenic (33)	As-73		5E-3
	As-74		5E-4
	As-76		2E-4
	As-77		8E-4
Barium (56)	Ba-131		2E-3
	Ba-140		3E-4
Beryllium (4)	Be-7		2E-2
Bismuth (83)	Bi-206		4E-4
Bromine (35)	Br-82	4E-7	3E-3
Cadmium (48)	Cd-109		2E-3
	Cd-115m		3E-4
	Cd-115		3E-4
Calcium (20)	Ca-45		9E-5
	Ca-47		5E-4
Carbon (6)	C-14	1E-6	8E-3
Cerium (58)	Ce-141		9E-4
	Ce-143		4E-4
	Ce-144		1E-4
Cesium (55)	Cs-131		2E-2
	Cs-134m		6E-2
	Cs-134		9E-5
Chlorine (17)	Cl-38	9E-7	4E-3
Chromium (24)	Cr-51		2E-2
Cobalt (27)	Co-57		5E-3
	Co-58		1E-3
	Co-60		5E-4
Copper (29)	Cu-64		3E-3

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Radioactive Material	Microcuries
Selenium-75 (Se 75)	10
Silicon-31 (Si 31)	100
Silver-105 (Ag 105)	10
Silver-110m (Ag 110m)	1
Silver-111 (Ag 111)	100
Sodium-22 (Na 22)	10
Sodium-24 (Na 24)	10
Strontium-85 (Sr 85)	10
Strontium-89 (Sr 89)	1
Strontium-90 (Sr 90)	0.1
Strontium-91 (Sr 91)	10
Strontium-92 (Sr 92)	10
Sulphur-35 (S 35)	100
Tantalum-182 (Ta 182)	10
Technetium-96 (Tc 96)	10
Technetium-97m (Tc 97m)	100
Technetium-97 (Tc 97)	100
Technetium-99m (Tc 99m)	100
Technetium-99 (Tc 99)	10
Tellurium-125m (Te 125m)	10
Tellurium-127m (Te 127m)	10
Tellurium-127 (Te 127)	100
Tellurium-129m (Te 129m)	10
Tellurium-129 (Te 129)	100
Tellurium-131m (Te 131m)	10
Tellurium-132 (Te 132)	10
Terbium-160 (Tb 160)	10
Thallium-200 (Tl 200)	100
Thallium-201 (Tl 201)	100
Thallium-202 (Tl 202)	100
Thallium-204 (Tl 204)	10
Thulium-170 (Tm 170)	10
Thulium-171 (Tm 171)	10
Tin-113 (Sn 113)	10
Tin-125 (Sn 125)	10
Tungsten-181 (W 181)	10
Tungsten-185 (W 185)	10
Tungsten-187 (W 187)	100
Vanadium-48 (V 48)	10
Xenon-131m (Xe 131m)	1,000
Xenon-133 (Xe 133)	100
Xenon-135 (Xe 135)	100
Ytterbium-175 (Yb 175)	100
Yttrium-87 (Y 87)	10

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Radioactive Material	Microcuries
Yttrium-90 (Y 90)	10
Yttrium-91 (Y 91)	10
Yttrium-92 (Y 92)	100
Yttrium-93 (Y 93)	100
Zinc-65 (Zn 65)	10
Zinc-69m (Zn 69m)	100
Zinc-69 (Zn 69)	1,000
Zirconium-93 (Zr 93)	10
Zirconium-95 (Zr 95)	10
Zirconium-97 (Zr 97)	10
Any radioactive material not listed above other than alpha emitting radioactive material	0.1

NOTE: To convert microcuries (μCi) to SI units of kilobecquerels (kBq), multiply the above values by 37.

EXAMPLE: Zirconium-97 (10 μCi multiplied by 37 is equivalent to 370 kBq).

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APPENDIX 003-C

LIMITS FOR BROAD LICENSES 003.13

Radioactive Material	Col. I curies	Col. II curies
Antimony-122	1	0.01
Antimony-124	1	0.01
Antimony-125	1	0.01
Arsenic-73	10	0.1
Arsenic-74	1	0.01
Arsenic-76	1	0.01
Arsenic-77	10	0.1
Barium-131	10	0.1
Barium-140	1	0.01
Beryllium-7	10	0.1
Bismuth-210	0.1	0.001
Bromine-82	10	0.1
Cadmium-109	1	0.01
Cadmium-115m	1	0.01
Cadmium-115	10	0.1
Calcium-45	1	0.01
Calcium-47	10	0.1
Carbon-14	100	1.0
Cerium-141	10	0.1
Cerium-143	10	0.1
Cerium-144	0.1	0.001
Cesium-131	100	1.0
Cesium-134m	100	1.0
Cesium-134	0.1	0.001
Cesium-135	1	0.01
Cesium-136	10	0.1
Cesium-137	0.1	0.001
Chlorine-36	1	0.01
Chlorine-38	100	1.0
Chromium-51	100	1.0
Cobalt-57	10	0.1
Cobalt-58m	100	1.0
Cobalt-58	1	0.01
Cobalt-60	0.1	0.001
Copper-64	10	0.1
Dysprosium-165	100	1.0
Dysprosium-166	10	0.1

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Radioactive Material	Col. I curies	Col. II curies
Erbium-169	10	0.1
Erbium-171	10	0.1
Europium-152 (9.2h)	10	0.1
Europium-152 (13 y)	0.1	0.001
Europium-154	0.1	0.001
Europium-155	1	0.01
Fluorine-18	100	1.0
Gadolinium-153	1	0.01
Gadolinium-159	10	0.1
Gallium-72	10	0.1
Germanium-71	100	1.0
Gold-198	10	0.1
Gold-199	10	0.1
Hafnium-181	1	0.01
Holmium-166	10	0.1
Hydrogen-3	100	1.0
Indium-113m	100	1.0
Indium-114m	1	0.01
Indium-115m	100	1.0
Indium-115	1	0.01
Iodine-125	0.1	0.001
Iodine-126	0.1	0.001
Iodine-129	0.1	0.001
Iodine-131	0.1	0.001
Iodine-132	10	0.1
Iodine-133	1	0.01
Iodine-134	10	0.1
Iodine-135	1	0.01
Iridium-192	1	0.01
Iridium-194	10	0.1
Iron-55	10	0.1
Iron-59	1	0.01
Krypton-85	100	1.0
Krypton-87	10	0.1
Lanthanum-140	1	0.01
Lutetium-177	10	0.1
Manganese-52	1	0.01
Manganese-54	1	0.01
Manganese-56	10	0.1
Mercury-197m	10	0.1
Mercury-197	10	0.1

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Radioactive Material	Col. I curies	Col. II curies
Mercury-203	1	0.01
Molybdenum-99	10	0.1
Neodymium-147	10	0.1
Neodymium-149	10	0.1
Nickel-59	10	0.1
Nickel-63	1	0.01
Nickel-65	10	0.1
Niobium-93m	1	0.01
Niobium-95	1	0.01
Niobium-97	100	1.0
Osmium-185	1	0.01
Osmium-191m	100	1.0
Osmium-191	10	0.1
Osmium-193	10	0.1
Palladium-103	10	0.1
Palladium-109	10	0.1
Phosphorus-32	1	0.01
Platinum-191	10	0.1
Platinum-193m	100	1.0
Platinum-193	10	0.1
Platinum-197m	100	1.0
Platinum-197	10	0.1
Polonium-210	0.01	0.0001
Potassium-42	1	0.01
Praseodymium-142	10	0.1
Praseodymium-143	10	0.1
Promethium-147	1	0.01
Promethium-149	10	0.1
Radium-226	0.01	0.0001
Rhenium-186	10	0.1
Rhenium-188	10	0.1
Rhodium-103m	1,000	10.0
Rhodium-105	10	0.1
Rubidium-86	1	0.01
Rubidium-87	1	0.01
Ruthenium-97	100	1.0
Ruthenium-103	1	0.01
Ruthenium-105	10	0.1
Ruthenium-106	0.1	0.001
Samarium-151	1	0.01
Samarium-153	10	0.1

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Radioactive Material	Col. I curies	Col. II curies
Scandium-46	1	0.01
Scandium-47	10	0.1
Scandium-48	1	0.01
Selenium-75	1	0.01
Silicon-31	10	0.1
Silver-105	1	0.01
Silver-110m	0.1	0.001
Silver-111	10	0.1
Sodium-22	0.1	0.001
Sodium-24	1	0.01
Strontium-85m	1,000	10.0
Strontium-85	1	0.01
Strontium-89	1	0.01
Strontium-90	0.01	0.0001
Strontium-91	10	0.1
Strontium-92	10	0.1
Sulphur-35	10	0.1
Tantalum-182	1	0.01
Technetium-96	10	0.1
Technetium-97m	10	0.1
Technetium-97	10	0.1
Technetium-99m	100	1.0
Technetium-99	1	0.01
Tellurium-125m	1	0.01
Tellurium-127m	1	0.01
Tellurium-127	10	0.1
Tellurium-129m	1	0.01
Tellurium-129	100	1.0
Tellurium-131m	10	0.1
Tellurium-132	1	0.01
Terbium-160	1	0.01
Thallium-200	10	0.1
Thallium-201	10	0.1
Thallium-202	10	0.1
Thallium-204	1	0.01
Thulium-170	1	0.01
Thulium-171	1	0.01
Tin-113	1	0.01
Tin-125	1	0.01
Tungsten-181	1	0.01
Tungsten-185	1	0.01

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Radioactive Material	Col. I curies	Col. II curies
Tungsten-187	10	0.1
Vanadium-48	1	0.01
Xenon-131m	1,000	10.0
Xenon-133	100	1.0
Xenon-135	100	1.0
Ytterbium-175	10	0.1
Yttrium-90	1	0.01
Yttrium-91	1	0.01
Yttrium-92	10	0.1
Yttrium-93	1	0.01
Zinc-65	1	0.01
Zinc-69m	10	0.1
Zinc-69	100	1.0
Zirconium-93	1	0.01
Zirconium-95	1	0.01
Zirconium-97	1	0.01

Any radioactive material other than source material,
special nuclear material, or alpha emitting radioactive
material not listed above. 0.1 0.001

NOTE: To convert curies (Ci) to SI units of gigabecquerels (GBq) multiply the above values by 37

EXAMPLE: Zirconium-97 (Col. II) (0.01 Ci multiplied by 37 is equivalent to 0.37 GBq)

APPENDIX 003-D

Criteria Relating to Use of Financial Tests and Self-Guarantees for Providing Reasonable Assurance of Funds for Decommissioning.

1. Introduction

An applicant or licensee may provide reasonable assurance of the availability of funds for decommissioning based on furnishing its own guarantee that funds will be available for decommissioning costs and on a demonstration that the company passes the financial test of Section 2 of this Appendix. The terms of this self-guarantee are in Section 3 of this Appendix. This appendix establishes criteria for passing the financial test for the self-guarantee and establishes the terms for obtaining a self-guarantee.

2. Financial Test

A. To pass the financial test, a company must meet all of the following criteria:

- (1) Tangible net worth of at least 10 times the total current decommissioning cost estimate (or the current amount if certification is used) for all decommissioning activities for which the company is responsible as self-guaranteeing licensee and a parent-guarantor.
- (2) Assets located in the United States amounting to at least 90 percent of total assets or at least 10 times the total current decommissioning cost estimate (or the current amount if certification is used) for all decommissioning activities for which the company is responsible as self-guaranteeing licensee and a parent-guarantor.
- (3) A current rating for its most recent bond issuance of AAA, AA, or A as issued by Standard and Poor's (S&P) or Aaa, Aa, or A as issued by Moody's.

B. To pass the financial test, a company must meet all of the following additional requirements:

- (1) The company must have at least one class of equity securities registered under the Securities Exchange Act of 1934.
- (2) The company's independent certified public accountant must have compared the data used by the company in the financial test, which is derived from the independently audited, year end financial statements for the latest fiscal year, with the amounts in such financial statement. In connection with that procedure, the licensee shall inform the Agency within 90 days of any matters coming to the attention of the auditor that cause the auditor to believe that the data specified in the financial test should be adjusted and that the company no longer passes the test.
- (3) After the initial financial test, the company must repeat the passage of the test within 90 days after the close of each succeeding fiscal year.

C. If the company no longer meets the requirements of Section 2.A. of this Appendix, the licensee must send immediate notice to the Agency of its intent to establish alternate financial assurance as specified in the Agency's regulations within 120 days of such notice.

3. Company Self-Guarantee

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The terms of a self-guarantee which an applicant or licensee furnishes shall provide that:

- A. The guarantee will remain in force unless the licensee sends notice of cancellation by certified mail to the Agency. Cancellation may not occur, however during the 120 days beginning on the date of receipt of the notice of cancellation by the Agency, as evidenced by the return receipt.
- B. The licensee shall provide alternative financial assurance as specified in the Agency's regulations within 90 days following receipt by the Agency of a notice of cancellation of the guarantee.
- C. The guarantee and financial test provisions must remain in effect until the Agency has terminated the license or until another financial assurance method acceptable to the Agency has been put in effect by the licensee.
- D. The licensee will promptly forward to the Agency and the licensee's independent auditor all reports covering the latest fiscal year filed by the licensee with the Securities and Exchange Commission pursuant to the requirements of Section 13 of the Securities and Exchange Act of 1934.
- E. If, at any time, the licensee's most recent bond issuance ceases to be rated in any category of "A" or above by either Standard and Poors or Moody's, the licensee will provide notice in writing of such fact to the Agency within 20 days after publication of the change by the rating service. If the licensee's most recent bond issuance ceases to be rated in any category of "A" or above by both Standard and Poors or Moody's, the licensee no longer meets the requirements of Section 2.A. of this Appendix.
- F. The applicant or licensee must provide to the Agency a written guarantee (a written commitment by a corporate officer) which states that the licensee will fund and carry out the required decommissioning activities or, upon issuance of an order by the Agency, the licensee will set up and fund a trust in the amount of the current cost estimate for decommissioning.

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APPENDIX 003-E

Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release.

Radioactive material ¹	Release fraction	Quantity (curies)
Actinium-228	0.001	4,000
Americium-241	0.001	2
Americium-242	0.001	2
Americium-243	0.001	2
Antimony-124	0.01	4,000
Antimony-126	0.01	6,000
Barium-133	0.01	10,000
Barium-140	0.01	30,000
Bismuth-207	0.01	5,000
Bismuth-210	0.01	600
Cadmium-109	0.01	1,000
Cadmium-113	0.01	80
Calcium-45	0.01	20,000
Californium-252	0.001	9 (20 mg)
Carbon-14 (Non CO)	0.01	50,000
Cerium-141	0.01	10,000
Cerium-144	0.01	300
Cesium-134	0.01	2,000
Cesium-137	0.01	3,000
Chlorine-36	0.5	100
Chromium-51	0.01	300,000
Cobalt-60	0.001	5,000
Copper-64	0.01	200,000
Curium-242	0.001	60
Curium-243	0.001	3
Curium-244	0.001	4
Curium-245	0.001	2
Europium-152	0.01	500
Europium-154	0.01	400
Europium-155	0.01	3,000
Germanium-68	0.01	2,000
Gadolinium-153	0.01	5,000
Gold-198	0.01	30,000
Hafnium-172	0.01	400
Hafnium-181	0.01	7,000
Holmium-166m	0.01	100
Hydrogen-3	0.5	20,000
Iodine-125	0.5	10
Iodine-131	0.5	10

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Radioactive material ¹	Release fraction	Quantity (curies)
Indium-114m	0.01	1,000
Iridium-192	0.001	40,000
Iron-55	0.01	40,000
Iron-59	0.01	7,000
Krypton-85	1.0	6,000,000
Lead-210	0.01	8
Manganese-56	0.01	60,000

"Inhalation class" [See "Class"].

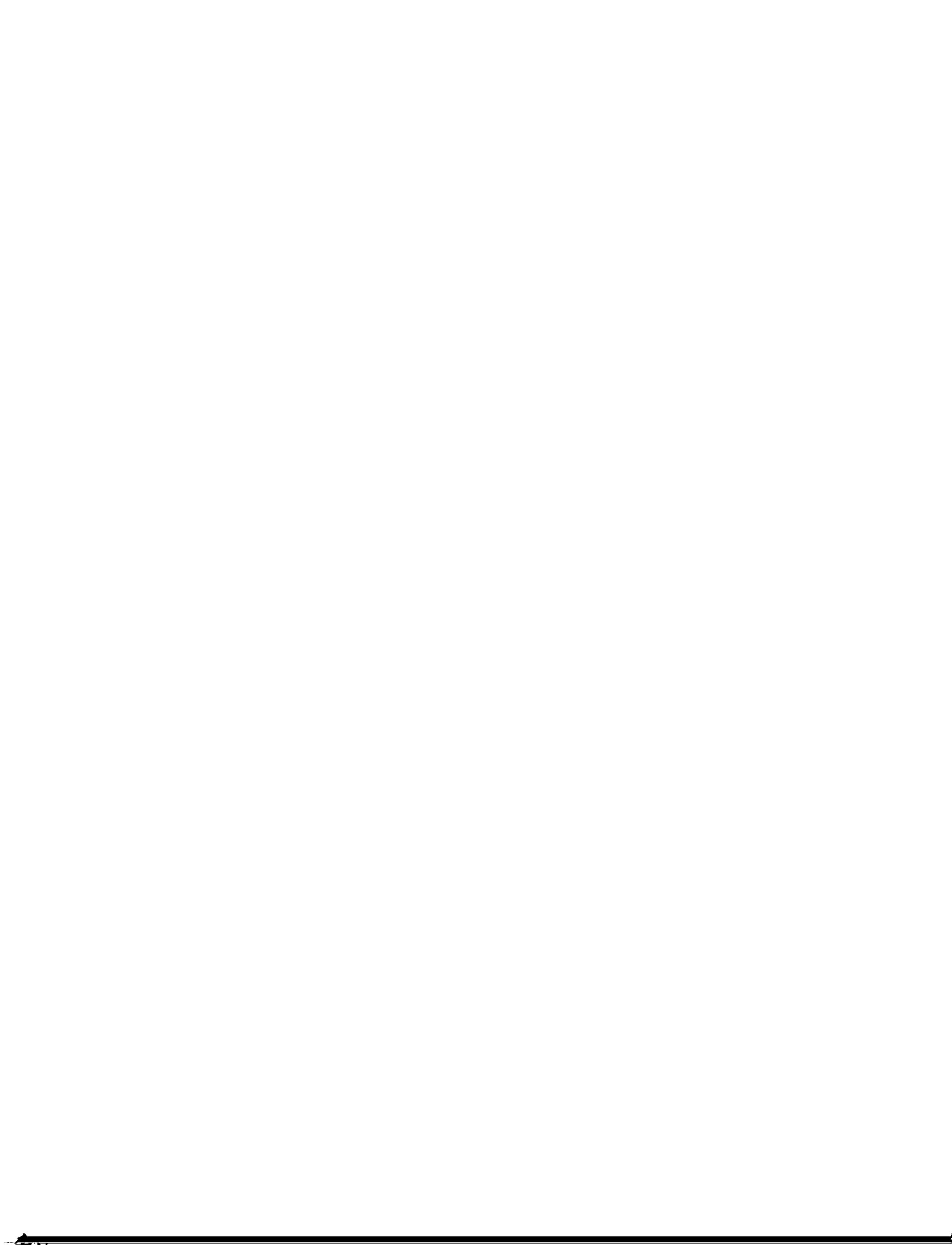
"Lung class" [See "Class"].

"Nonstochastic effect" means a health effect, 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. For purposes of these regulations, a "deterministic effect" is an equivalent term.

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

"Quarter" means a period of time equal to one-fourth of the year observed by the licensee or registrant, 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.

"Reference man" means a hypothetical aggregation of human physical and physiological characteristics determined by international consensus. These characteristics may be used by researchers and public



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"Weighting factor" w_T for an organ or tissue (T) means 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 ^a
Whole Body	1.00 ^b

^a 0.30 results from 0.06 for each of 5 "remainder" organs, excluding the skin and the lens of the eye, that receive the highest doses.

^b 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.

004.04 Implementation.

004.04A Any existing license condition that is more restrictive than Section 004 remains in force until there is an amendment or renewal of the license.

004.04B If a license condition exempts a licensee from a provision of Section 004 in effect on or before the effective date of these regulations, it also exempts the licensee from the corresponding provision of Section 004.

004.04C If a license condition cites provisions of Section 004 in effect prior to the effective date of these regulations, which do not correspond to any provisions of Section 004, the license condition remains in force until there is an amendment or renewal of the license that modifies or removes this condition.

RADIATION PROTECTION PROGRAMS

004.05 Radiation Protection Programs.

004.05A Each licensee or registrant shall develop, document, and implement a radiation protection program sufficient to ensure compliance with the provisions of Section 004. See 004.46 for recordkeeping requirements relating to these programs.

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004.05B The licensee or registrant shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and public doses that are as low as is reasonably achievable (ALARA).

004.05C The licensee or registrant shall, at intervals not to exceed 12 months, review the radiation protection program content and implementation.

004.05D To implement the ALARA requirements of 004.05B and notwithstanding the requirements in 004.14 of this section, a constraint on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters shall be established by licensees, such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 10 mrem (0.1 mSv) per year from these emissions. If a licensee subject to this requirement exceeds this dose constraint, the licensee shall report the exceedance as provided in 004.58 and promptly take appropriate corrective action to ensure against a recurrence.

OCCUPATIONAL DOSE LIMITS

004.06 Occupational Dose Limits for Adults.

004.06A The licensee or registrant shall control the occupational dose to individual adults, except for planned special exposures pursuant to 004.11, to the following dose limits:

004.06A1 An annual limit, which is the more limiting of:

004.06A1a The total effective dose equivalent being equal to 0.05 Sv (5 rem); or

004.06A1b 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 0.5 Sv (50 rem).

004.06A2 The annual limits to the lens of the eye, to the skin, and to the extremities which are:

004.06A2a An eye dose equivalent of 0.15 Sv (15 rem), and

004.06A2b A shallow dose equivalent of 0.5 Sv (50 rem) to the skin or to any extremity.

004.06B 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 and during the individual's lifetime. See 004.11E1 and 2.

004.06C The assigned deep dose equivalent and shallow dose equivalent shall be for the portion of the body receiving the highest exposure.

004.06D 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.

004.06E Derived air concentration (DAC) and annual limit on intake (ALI) values are presented in Table I of Appendix 004-B and may be used to determine the individual's dose and to demonstrate compliance with the occupational dose limits. See 004.51.

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004.06F Notwithstanding 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 004-B.

004.06G The licensee or registrant 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 004.10E.

004.07 Compliance with Requirements for Summation of External and Internal Doses.

004.07A If the licensee is required to monitor pursuant to both 004.23A and B, the licensee shall demonstrate compliance with the dose limits by summing external and internal doses. If the licensee or registrant is required to monitor only pursuant to 004.23A or only pursuant to 004.18B 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 pursuant to 004.07B, C, and D. 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.

004.07B 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:

004.07B1 The sum of the fractions of the inhalation ALI for each radionuclide, or

004.07B2 The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000, or

004.07B3 The sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For purposes of this requirement, 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, $H_{T,50}$, per unit intake is greater than 10 percent of the maximum weighted value of H_{50} (i.e., $w_T H_{T,50}$) per unit intake for any organ or tissue.

004.07C 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 or registrant shall account for this intake and include it in demonstrating compliance with the limits.

004.07D Intake through Wounds or Absorption through Skin. The licensee or registrant shall evaluate and, to the extent practical, account for intakes through wounds or skin absorption. The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be evaluated or accounted for pursuant to 004.07D.

004.08 Determination of External Dose from Airborne Radioactive Material.

004.08A 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 004-B, footnotes 1 and 2.

004.08B Airborne radioactivity measurements and DAC values shall not be used as the primary means to assess the deep dose equivalent when the airborne radioactive material includes

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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 shall be based upon measurements using instruments or individual monitoring devices.

004.09 Determination of Internal Exposure.

004.09A For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee shall, when required under 004.23 take suitable and timely measurements of:

004.09A1 Concentrations of radioactive materials in air in work areas; or

004.09A2 Quantities of radionuclides in the body; or

004.09A3 Quantities of radionuclides excreted from the body; or

004.09A4 Combinations of these measurements.

004.09B Unless respiratory protective equipment is used, as provided in 004.29 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.

004.09C 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:

004.09C1 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

004.09C2 Upon prior approval of the Agency, adjust the DAC or ALI values to reflect the actual physical and chemical characteristics of airborne radioactive material, for example, aerosol size distribution or density; and

004.09C3 Separately assess the contribution of fractional intakes of Class D, W, or Y compounds of a given radionuclide to the committed effective dose equivalent. See Appendix 004-B.

004.09D If the licensee chooses to assess intakes of Class Y material using the measurements given in 004.09A, 2 or 3, the licensee may delay the recording and reporting of the assessments for periods up to 7 months, unless otherwise required by 004.57 or 004.58. This delay permits the licensee to make additional measurements basic to the assessments.

004.09E 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 shall be either:

004.09E1 The sum of the ratios of the concentration to the appropriate DAC value, (e.g., D, W, or Y) from Appendix 004-B for each radionuclide in the mixture; or

004.09E2 The ratio of the total concentration for all radionuclides in the mixture to the most restrictive DAC value for any radionuclide in the mixture.

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004.09F 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.

004.09G When a mixture of radionuclides in air exists, a licensee may disregard certain radionuclides in the mixture if:

004.09G1 The licensee uses the total activity of the mixture in demonstrating compliance with the dose limits in 004.06 and in complying with the monitoring requirements in 004.23, and

004.09G2 The concentration of any radionuclide disregarded is less than 10 percent of its DAC, and

004.09G3 The sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30 percent.

004.09H When determining the committed effective dose equivalent, the following information may be considered:

004.09H1 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 0.05 Sv (5 rem) for radionuclides that have their ALIs or DACs based on the committed effective dose equivalent.

004.09H2 For an ALI (and the associated DAC) determined by the nonstochastic organ dose limit of 0.5 Sv (50 rem), the intake of radionuclides that would result in a committed effective dose equivalent of 0.05 Sv (5 rem), (the stochastic ALI) is listed in parentheses in Table I of Appendix 004-B. The licensee may, as a simplifying assumption, use the stochastic ALI to determine committed effective dose equivalent. However, if the licensee uses the stochastic ALI, the licensee shall also demonstrate that the limit in 004.06A1b is met.

004.10 Determination of Prior Occupational Dose.

004.10A For each individual who may enter the licensee's or registrant's restricted area and is likely to receive, in a year, an occupational dose requiring monitoring pursuant to 004.23, the licensee or registrant shall:

004.10A1 Determine the occupational radiation dose received during the current year; and

004.10A2 Attempt to obtain the records of cumulative occupational radiation dose.

004.10B Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant shall determine:

004.10B1 The internal and external doses from all previous planned special exposures; and

004.10B2 All doses in excess of the limits (including doses received during accidents and emergencies) received during the lifetime of the individual.

004.10C In complying with the requirements of 004.10A, a licensee or registrant may:

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004.10C1 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 received during the current year; and

004.10C2 Accept, as the record of cumulative radiation dose, an up-to-date Agency Form NRH-1 or equivalent signed by the individual and countersigned by an appropriate official of the most

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004.18A5 Residual radioactivity at the site has been reduced so that if the institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is as low as reasonably achievable and would not exceed either:

004.18A5a 100 mrem (1 mSv) per year; or (1 mSv) per year; or

004.18A5b 500 mrem (5 mSv) per year provided the licensee;

004.18A5b(1) Demonstrates that further reductions in residual radioactivity necessary to comply with the 100 mrem/y (1 mSv/y) value of 004.18A5a of this subsection are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm;

004.18A5b(2) Makes provisions for durable institutional controls;

004.18A5b(3) Provides sufficient financial assurance to enable a responsible government entity or independent third party, including a governmental custodian of a site both to carry out periodic rechecks of the site, no less frequently than every 5 years to assure that the institutional controls necessary to meet the criteria of 004.18A2 and to assume and carry out responsibilities for any necessary control and, maintenance of those controls. Acceptable financial assurance mechanisms are those in 004.18A3.

004.19 Alternate Criteria for License Termination.

004.19A The Agency may terminate a license using alternate criteria greater than the dose criterion of 004.17, 004.18A2, and 004.18A4a(1)(a), if the licensee:

004.19A1 Provides assurance that public health and safety would continue to be protected, and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 1 mSv/y (100 mrem/y) limit of 004.14A1, by submitting an analysis of possible sources of exposure;

004.19A2 Has employed to the extent practical restrictions on site use according to the provisions of 004.18 in minimizing exposures at the site; and

004.19A3 Reduces doses to ALARA levels, taking into consideration any detriments such as traffic accidents expected to potentially result from decontamination and waste disposal.

004.19A4 Has submitted a decommissioning plan or License Termination Plan to the Agency indicating the licensee's intent to decommission in accordance with Subsection 003.19D and specifying that the licensee proposes to decommission by use of alternate criteria. The licensee shall document in the decommissioning plan or License Termination Plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and addressed, as appropriate, following analysis of that advice. In seeking such advice, the licensee shall provide for:

004.19A4a Participation by representatives of a broad cross section of community interests who may be affected by the decommissioning;

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004.19A4b An opportunity for a comprehensive, collective discussion on the issues by the participants represented; and

004.19A4c A publicly available summary of the results of all such discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues.

004.19B The use of alternate criteria to terminate a license requires the approval of the Agency after consideration of the Agency staff's recommendations that will address any comments provided by the Environmental Protection Agency and any public comments submitted pursuant to 004.20.

004.20 Public Notification and Public Participation.

004.20A Upon the receipt of the License Termination Plan or decommissioning plan from the licensee, or a proposal by the licensee for release of a site pursuant to 004.18 and 004.19, or whenever the Agency deems such notice to be in the public interest, the Agency shall:

004.20A1 Notify and solicit comments from:

004.20A1a Local and State governments in the vicinity of the site and any Indian Nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning; and

004.20A1b The Environmental Protection Agency for cases where the licensee proposes to release a site pursuant to 004.19.

004.20B Publish a notice in a forum, such as local newspapers, letters to the State or local organizations, or other appropriate forum, that is readily accessible to individuals in the vicinity of the site, and solicit comments from affected parties.

004.21 Minimization of Contamination. Applicants for licenses, other than renewals, shall describe in the application how the facility design and the procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

SURVEYS AND MONITORING

004.22 General.

004.22A Each licensee or registrant shall make, or cause to be made, surveys that:

004.22A1 Are necessary for the licensee or registrant to comply with Section 004; and

004.22A2 Are necessary under the circumstances to evaluate:

004.22A2a Radiation levels; and

004.22A2b Concentrations or quantities of radioactive material; and

004.22A2c The potential radiological hazards that could be present.

004.22B The licensee or registrant shall ensure that instruments and equipment used for quantitative radiation measurements (e.g., dose rate and effluent monitoring) are calibrated at intervals

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not to exceed 12 months for the radiation measured, except when a more frequent interval is specified in another applicable Section of these regulations or a license condition.

004.22C All personnel dosimeters (except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to any extremity) that require processing to determine the radiation dose and that are used by licensees and registrants to comply with 004.06, with other applicable provisions of these regulations, or with conditions specified in a license or registration shall be processed and evaluated by a dosimetry processor:

004.22C1 Holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology; and

004.22C2 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.

004.22D The licensee or registrant shall ensure that adequate precautions are taken to prevent a deceptive exposure of an individual monitoring device.

004.23 Conditions Requiring Individual Monitoring of External and Internal Occupational Dose.

Each licensee or registrant shall monitor exposures from sources of radiation at levels sufficient to demonstrate compliance with the occupational dose limits of Section 004. As a minimum:

004.23A Each licensee or registrant shall monitor occupational exposure to radiation and shall supply and require the use of individual monitoring devices by:

004.23A1 Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in 004.06A; and

004.23A2 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 004.12 or 004.13; and

004.23A3 Individuals entering a high or very high radiation area.

004.23B Each licensee or registrant shall monitor, to determine compliance with 004.09, the occupational intake of radioactive material by and assess the committed effective dose equivalent to:

004.23B1 Adults likely to receive, in 1 year, an intake in excess of 10 percent of the applicable ALI in Table I, Columns 1 and 2, of Appendix 004-B; and

004.23B2 Minors and declared pregnant women likely to receive, in 1 year, a committed effective dose equivalent in excess of 0.5 mSv (0.05 rem).

CONTROL OF EXPOSURE FROM EXTERNAL SOURCES IN RESTRICTED AREAS

004.24 Control of Access to High Radiation Areas.

004.24A The licensee or registrant shall ensure that each entrance or access point to a high radiation area has one or more of the following features:

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004.24A1 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 1 mSv (0.1 rem) in 1 hour at 30 centimeters from the source of radiation from any surface that the radiation penetrates; or

004.24A2 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

004.24A3 Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

004.24B In place of the controls required by 004.24A for a high radiation area, the licensee or registrant may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry.

004.24C The licensee or registrant may apply to the Agency for approval of alternative methods for controlling access to high radiation areas.

004.24D The licensee or registrant shall establish the controls required by 004.24A and C in a way that does not prevent individuals from leaving a high radiation area.

004.24E The licensee or registrant is not required to control 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 U.S. Department of Transportation provided that:

004.24E1 The packages do not remain in the area longer than 3 days; and

004.24E2 The dose rate at 1 meter from the external surface of any package does not exceed 0.1 mSv (0.01 rem) per hour.

004.24F The licensee is not required to control entrance or access to rooms or other areas in hospitals solely because of the presence of patients containing radioactive material, provided that there are personnel in attendance who are taking the necessary precautions to prevent the exposure of individuals to radiation or radioactive material in excess of the established limits in Section 004 and to operate within the ALARA provisions of the licensee's or registrant's radiation protection program.

004.24G The registrant is not required to control entrance or access to rooms or other areas containing sources of radiation capable of producing a high radiation area as described in 004.24 if the registrant has met all the specific requirements for access and control specified in other applicable Sections of these regulations, such as, Section 005 for industrial radiography, Section 006 for x-rays in the healing arts, and Section 009 for particle accelerators.

004.25 Control of Access to Very High Radiation Areas.

004.25A In addition to the requirements in 004.24, the licensee or registrant shall institute 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 5 Gy (500 rad) or more in 1 hour at 1 meter from a source of radiation or any surface through which the radiation penetrates. This requirement does not apply to

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rooms or areas in which diagnostic x-ray systems are the only source of radiation, or to non-self-shielded irradiators.

004.25B The registrant is not required to control entrance or access to rooms or other areas containing sources of radiation capable of producing a very high radiation area as described in 004.25A if the registrant has met all the specific requirements for access and control specified in other applicable Sections of these regulations, such as, Section 005 for industrial radiography, Section 006 for x-rays in the healing arts, and Section 009 for particle accelerators.

004.26 Control of Access to Very High Radiation Areas – Irradiators.

004.26A Section 004.26 applies to registrants with sources of radiation in non-self-shielded irradiators. Section 004.26 does not apply to sources of radiation that are used in teletherapy, in industrial radiography, or in completely self-shielded irradiators in which the source of radiation 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.

004.26B Each area in which there may exist radiation levels in excess of 5 Gy (500 rad) in 1 hour at 1 meter from a source of radiation that is used to irradiate materials shall meet the following requirements:

004.26B1 Each entrance or access point must be equipped with entry control devices which:

004.26 B1a Function automatically to prevent any individual from inadvertently entering a very high radiation area; and

004.26B1b Permit deliberate entry into the area only after a control device is actuated that causes the radiation level within the area, from the source of radiation, to be reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

004.26B1c Prevent operation of the source of radiation if it would produce radiation levels in the area that could result in a deep dose equivalent to an individual in excess of 1 mSv (0.1 rem) in 1 hour.

004.26B2 Additional control devices shall be provided so that, upon failure of the entry control devices to function as required by 004.26B1:

004.26B2a The radiation level within the area, from the source of radiation, is reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

004.26B2b 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.

004.26B3 The registrant shall provide control devices so that, upon failure or removal of physical radiation barriers:

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004.26B3a The radiation level from the source of radiation is reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

004.26B3b Conspicuous visible and audible alarm signals are generated to make potentially affected individuals aware of the hazard and the registrant 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.

004.26B4 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 004.26B3.

004.26B5 Each area shall be equipped with devices that will automatically generate conspicuous visible and audible alarm signals to alert personnel in the area before the source of radiation can be put into operation and in 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 of radiation from being put into operation.

004.26B6 Each area shall 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 of radiation.

004.26B7 Each area shall 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 of radiation, the radiation level from the source of radiation in the area is below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour.

004.26B8 The entry control devices required in 004.26B1 shall have been tested for proper functioning. See 004.54 for recordkeeping requirements.

004.26B8a Testing shall be conducted prior to initial operation with the source of radiation on any day, unless operations were continued uninterrupted from the previous day; and

004.26B8b Testing shall be conducted prior to resumption of operation of the source of radiation after any unintentional interruption; and

004.26B8c The registrant shall submit and adhere to a schedule for periodic tests of the entry control and warning systems.

004.26B9 The registrant shall not conduct operations, other than those necessary to place the source of radiation in safe condition or to effect repairs on controls, unless control devices are functioning properly.

004.26B10 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, shall 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.

004.26C Registrants or applicants for registrations for sources of radiation within the purview of 004.26B which will be used in a variety of positions or in locations, such as open fields or forests, that

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make it impracticable to comply with certain requirements of 004.26B, such as those for the automatic control of radiation levels, may apply to the Agency for approval of alternative safety measures. Alternative safety measures shall provide personnel protection at least equivalent to those specified in 004.26B. At least one of the alternative measures shall 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 sources of radiation are used.

004.26D The entry control devices required by 004.26B and C shall be established in such a way that no individual will be prevented from leaving the area.

**RESPIRATORY PROTECTION AND CONTROLS
TO RESTRICT INTERNAL EXPOSURE IN RESTRICTED AREAS**

004.27 Use of Process or Other Engineering Controls. The licensee or registrant shall use, to the extent practical, process or other engineering controls (for example, containment or ventilation) to control the concentrations of radioactive material in air.

004.28 Use of Other Controls. When it is not practical 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 or registrant shall, consistent with maintaining the total effective dose equivalent ALARA, increase monitoring and limit intakes by one or more of the following means:

- 004.28A Control of access; or
- 004.28B Limitation of exposure times; or
- 004.28C Use of respiratory protection equipment; or
- 004.28D Other controls.

004.29 Use of Individual Respiratory Protection Equipment.

004.29A If the licensee uses respiratory protection equipment to limit intakes pursuant to 004.28:

004.29A1 Except as provided in 004.29A2, 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 and the Mine Safety and Health Administration.

004.29A2 If the licensee wishes to use equipment that has not been tested or certified by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration, has not had certification extended by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration, or for which there is no schedule for testing or certification, the licensee or registrant 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.

004.29A3 The licensee shall implement and maintain a respiratory protection program that includes:

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004.29A3a Air sampling sufficient to identify the potential hazard, permit proper equipment selection, and estimate exposures; and

004.29A3b Surveys and bioassays, as appropriate, to evaluate actual intakes; and

004.29A3c Testing of respirators for operability immediately prior to each use; and

004.29A3d 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

004.29A3e Determination by a physician prior to initial fitting of respirators, and either every 12 months thereafter or periodically at a frequency determined by a physician, that the individual user is medically fit to use the respiratory protection equipment.

004.29A4 The licensee shall issue a written policy statement on respirator usage covering:

004.29A4a The use of process or other engineering controls, instead of respirators; and

004.29A4b The routine, nonroutine, and emergency use of respirators; and

004.29A4c The length of periods of respirator use and relief from respirator use.

004.29A5 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.

004.29A6 The licensee shall use respiratory protection equipment within the equipment manufacturer's expressed limitations for type and mode of use and shall provide proper visual, communication, and other special capabilities (such as adequate skin protection) when needed.

004.29B When estimating exposure of individuals to airborne radioactive materials, the licensee may make allowance for respiratory protection equipment used to limit intakes pursuant to 004.28, provided that the following conditions, in addition to those in 004.29A, are satisfied:

004.29B1 The licensee selects respiratory protection equipment that provides a protection factor, specified in Appendix A, 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 004-B, Table I, Column 3. However, if the selection of respiratory protection equipment with a protection factor greater than the peak concentration is inconsistent with the goal specified in 004.28 of keeping the total effective dose equivalent ALARA, the licensee may select respiratory protection equipment with a lower protection factor provided that such a selection would result in a total effective dose equivalent that is 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 initially estimated, the corrected value shall be used; if the exposure is later found to be less than initially estimated, the corrected value may be used.

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004.29B2 The licensee shall obtain authorization from the Agency before assigning respiratory protection factors in excess of those specified in Appendix A. The Agency may authorize a licensee to use higher protection factors on receipt of an application that:

004.29B2a Describes the situation for which a need exists for higher protection factors, and

004.29B2b Demonstrates that the respiratory protection equipment provides these higher protection factors under the proposed conditions of use.

004.29C In an emergency, the licensee shall use as emergency equipment only respiratory protection equipment that has been specifically certified or had certification extended for emergency use by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration.

004.29D The licensee shall notify the Agency in writing at least 30 days before the date that respiratory protection equipment is first used pursuant to either 004.29A or B.

**STORAGE AND CONTROL OF LICENSED OR REGISTERED
SOURCES OF RADIATION**

004.30 Security of Stored Sources of Radiation. The licensee or registrant shall secure from unauthorized removal or access licensed or registered sources of radiation that are stored in unrestricted areas.

004.31 Control of Sources of Radiation not in Storage.

004.31A The licensee or registrant shall control and maintain constant surveillance of licensed or registered radioactive material that is in an unrestricted area and that is not in storage.

004.31B The registrant shall maintain control of registered radiation machines that are in an unrestricted area and that are not in storage.

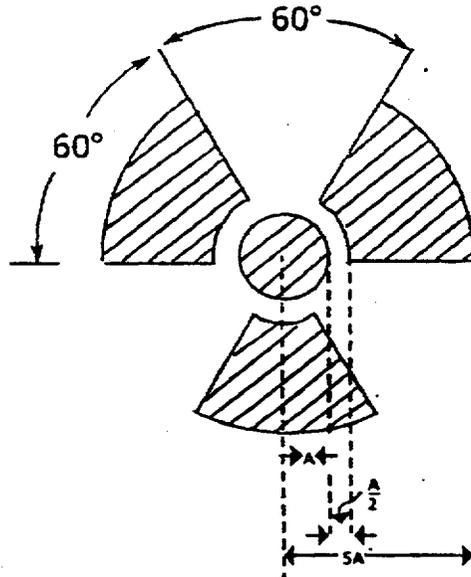
PRECAUTIONARY PROCEDURES

004.32 Caution Signs.

004.32A Standard Radiation Symbol. Unless otherwise authorized by the Agency, the symbol prescribed by 004.32 shall use the colors magenta, or purple, or black on yellow background. The symbol prescribed is the three-bladed design as follows:

RADIATION SYMBOL

1. Cross-hatched area is to be magenta, or purple, or black, and
2. The background is to be yellow.



004.32B Exception to Color Requirements for Standard Radiation Symbol. Notwithstanding the requirements of 004.32A, licensees or registrants are authorized to label sources, source holders, or device components containing sources of radiation that are subjected to high temperatures, with conspicuously etched or stamped radiation caution symbols and without a color requirement.

004.32C Additional Information on Signs and Labels. In addition to the contents of signs and labels prescribed in Section 004, the licensee or registrant shall 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.

004.33 Posting Requirements.

004.33A Posting of Radiation Areas. The licensee or registrant shall post each radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA."

004.33B Posting of High Radiation Areas. The licensee or registrant 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."

004.33C Posting of Very High Radiation Areas. The licensee or registrant 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."

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004.33D Posting of Airborne Radioactivity Areas. The licensee or registrant 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."

004.33E Posting of Areas or Rooms in which Licensed or Registered Material is Used or Stored. The licensee or registrant shall post each area or room in which there is used or stored an amount of licensed or registered material exceeding 10 times the quantity of such material specified in Appendix C with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

004.34 Exceptions to Posting Requirements.

004.34A A licensee or registrant is not required to post caution signs in areas or rooms containing sources of radiation for periods of less than 8 hours, if each of the following conditions is met:

004.34A1 The sources of radiation are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure of individuals to sources of radiation in excess of the limits established in Section 004; and

004.34A2 The area or room is subject to the licensee's or registrant's control.

004.34B Rooms or other areas in hospitals that are occupied by patients are not required to be posted with caution signs pursuant to 004.33 provided that the patient could be released from licensee control pursuant to 007.30 of these regulations.

004.34C 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 sealed source container or housing does not exceed 0.05 mSv (0.005 rem) per hour.

004.34D A room or area is not required to be posted with a caution sign because of the presence of radiation machines used solely for diagnosis in the healing arts.

004.35 Labeling Containers and Radiation Machines.

004.35A The licensee or registrant shall ensure that each container of licensed or registered material bears a durable, clearly visible label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label shall also provide information (such as the radionuclides 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.

004.35B Each licensee or registrant 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.

004.35C Each registrant shall ensure that each radiation machine is labeled in a conspicuous manner which cautions individuals that radiation is produced when it is energized.

004.36 Exemptions to Labeling Requirements. A licensee or registrant is not required to label:

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004.36A Containers holding licensed or registered material in quantities less than the quantities listed in Appendix C; or

004.36B Containers holding licensed or registered material in concentrations less than those specified in Table III of Appendix 004-B; or

004.36C Containers attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the limits established by Section 004; or

004.36D Containers when they are in transport and packaged and labeled in accordance with the regulations of the U.S. Department of Transportation³; or

004.36E 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 shall be retained as long as the containers are in use for the purpose indicated on the record; or

004.36F Installed manufacturing or process equipment, such as piping and tanks.

004.37 Procedures for Receiving and Opening Packages.

004.37A Each licensee who expects to receive a package containing quantities of radioactive material in excess of a Type A quantity, as defined in Part 013.02 and Appendix A of Section 013, shall make arrangements to receive:

004.37A1 The package when the carrier offers it for delivery; or

004.37A2 Notification of the arrival of the package at the carrier's terminal and to take possession of the package expeditiously.

004.37B Each licensee shall:

004.37B1 Monitor the external surfaces of a labeled⁴ package for radioactive contamination unless the package contains only radioactive material in the form of a gas or in special form as defined in Subsection 001.02 of these regulations; and

004.37B2 Monitor the external surfaces of a labeled⁴ package for radiation levels unless the package contains quantities of radioactive material that are less than or equal to the Type A quantity, as defined in Part 013.02 and Appendix A to Section 013 of these regulations; and

004.37B3 Monitor all packages known to contain radioactive material for radioactive contamination and radiation levels if there is evidence of degradation of package integrity, such as packages that are crushed, wet, or damaged.

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

⁴Labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in U.S. Department of Transportation regulations, 49 CFR 172.403 and 172.436-440.

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004.37C The licensee shall perform the monitoring required by 004.37B as soon as practical after receipt of the package, but not later than 3 hours after the package is received at the licensee's or registrant's facility if it is received during the licensee's or registrant'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.

004.37D The licensee shall immediately notify the final delivery carrier and, by telephone and telegram, mailgram, or facsimile, the Agency when:

004.37D1 Removable radioactive surface contamination exceeds the limits of Part 013.15H of these regulations; or

004.37D2 External radiation levels exceed the limits of Parts 013.15I and J of these regulations.

004.37E Each licensee shall:

004.37E1 Establish, maintain, and retain written procedures for safely opening packages in which radioactive material is received; and

004.37E2 Ensure that the procedures are followed and that due consideration is given to special instructions for the type of package being opened.

004.37F Licensees transferring special form sources in vehicles owned or operated by the licensee to and from a work site are exempt from the contamination monitoring requirements of 004.37B, but are not exempt from the monitoring requirement in 004.37B for measuring radiation levels that ensures that the source is still properly lodged in its shield.

WASTE DISPOSAL

004.38 General Requirements.

004.38A A licensee shall dispose of licensed material only:

004.38A1 By transfer to an authorized recipient as provided in 004.43 or in Sections 003, 012, or 019 of these regulations, or to the U.S. Department of Energy; or

004.38A2 By decay in storage; or

004.38A3 By release in effluents within the limits in 004.14; or

004.38A4 As authorized pursuant to 004.39, 004.40, 004.41, or 004.42.

004.38B A person shall be specifically licensed to receive waste containing licensed material from other persons for:

004.38B1 Treatment prior to disposal; or

004.38B2 Treatment or disposal by incineration; or

004.38B3 Decay in storage; or

004.38B4 Management at a facility licensed pursuant to Section 012 of these regulations; or

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004.38B5 Storage until transferred to a storage or disposal facility authorized to receive the waste.

004.39 Method for Obtaining Approval of Proposed Disposal Procedures. A licensee or applicant for a license may apply to the Agency for approval of proposed procedures, not otherwise authorized in these regulations, to dispose of licensed material generated in the licensee's operations. Each application shall include:

004.39A A description of the waste containing licensed or registered material to be disposed of, including the physical and chemical properties that have an impact on risk evaluation, and the proposed manner and conditions of waste disposal; and

004.39B An analysis and evaluation of pertinent information on the nature of the environment; and

004.39C The nature and location of other potentially affected facilities; and

004.39D Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in Section 004.

004.40 Disposal by Release into Sanitary Sewerage.

004.40A A licensee may discharge licensed material into sanitary sewerage if each of the following conditions is satisfied:

004.40A1 The material is readily soluble, or is readily dispersible biological material, in water; and

004.40A2 The quantity of licensed 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 III of Appendix 004-B; and

004.40A3 If more than one radionuclide is released, the following conditions must also be satisfied:

004.40A3a The licensee shall determine the fraction of the limit in Table III of Appendix 004-B represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee or registrant into the sewer by the concentration of that radionuclide listed in Table III of Appendix 004-B; and

004.40A3b The sum of the fractions for each radionuclide required by 004.40A3a does not exceed unity; and

004.40A4 The total quantity of licensed radioactive material that the licensee releases into the sanitary sewerage system in a year does not exceed 185 GBq (5 Ci) of hydrogen-3, 37 GBq (1 Ci) of carbon-14, and 37 GBq (1 Ci) of all other radioactive materials combined.

004.40B Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to the limitations contained in 004.40A.

004.41 Treatment or Disposal by Incineration. A licensee may treat or dispose of licensed material by incineration only in the amounts and forms specified in 004.42 or as specifically approved by the Agency pursuant to 004.39.

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004.42 Disposal of Specific Wastes.

004.42A A licensee may dispose of the following licensed material as if it were not radioactive:

004.42A1 1.85 kBq (0.05 μ Ci), or less, of Hydrogen-3, Carbon-14 or Iodine-125 per gram of medium used for liquid scintillation counting; and

004.42A2 1.85 kBq (0.05 μ Ci), or less, of Hydrogen-3, or Carbon-14 or Iodine-125 per gram of animal tissue, averaged over the weight of the entire animal.

004.42B A licensee shall not dispose of tissue pursuant to 004.42A2 in a manner that would permit its use either as food for humans or as animal feed.

004.42C The licensee shall maintain records in accordance with 004.53.

004.42D Any licensee may, upon Agency approval of procedures required in 004.42F, dispose of radioactive material included in Appendix 004-G, provided that it does not exceed the concentration and total curie limits contained therein. Any radioactive material included in Appendix 004-G may be disposed of at a city or county landfill facility authorized to receive the radioactive material.

004.42E Each licensee who disposes of radioactive material described in 004.42A or D shall:

004.42E1 Make surveys adequate to assure that the limits of 004.42A or D are not exceeded; and

004.42E2 Remove or otherwise obliterate all labels, tags, or other markings which would indicate that the material or its contents is radioactive.

004.42F Prior to the initiation of disposals authorized by 004.42D, a licensee shall submit procedures to the Agency for:

004.42F1 The physical delivery of the material to the disposal site, the physical placing of the material in the disposal location and that the material is properly covered;

004.42F2 Surveys to be performed for compliance with 004.42E1;

004.42F3 Maintaining secure packaging during transportation to the site;

004.42F4 Maintaining records of disposals made under 004.42D; and

004.42F5 Written authorization by the landfill operator agreeing to such disposal.

004.42G Nothing in this section, however, relieves the licensee of maintaining records showing the receipt, transfer, and disposal of such radioactive material as specified pursuant to 001.04 of these regulations.

004.42H Nothing in this section relieves the licensee from complying with other applicable federal, state or local regulations governing any other toxic or hazardous property of these materials.

004.42I Radioactive material disposed of under this section is not subject to the requirements of Section 013 of these regulations.

004.43 Transfer for Disposal and Manifests.

004.43A The requirements of this section and Appendix 004-D are designed to:

004.43A1 Control transfers of low-level radioactive waste by any waste generator, waste collector, or waste processor license, as defined in this section, who ships low-level waste either directly, or indirectly through a waste collector or waste processor, to a licensed low-level waste disposal facility.

004.43A2 Establish a manifest tracking system; and

004.43A3 Supplement existing requirements concerning transfers and recordkeeping for those wastes.

004.43B All affected licensees must use Appendix 004-D and comply with subpart 004.43B2 of this section.

004.43B1 Each shipment of radioactive waste intended for disposal at a licensed low-level radioactive waste disposal facility must be accompanied by a shipment manifest as specified in Section I of Appendix 004-D.

004.43B2 Any licensee shipping radioactive waste intended for ultimate disposal at a licensed land disposal facility must document the information required on the Agency's Uniform Low-Level Radioactive Waste Manifest and transfer this recorded manifest information to the intended consignee in accordance with Appendix 004-D of this section.

004.43C Each shipment manifest must include a certification by waste generator as specified in Section II of Appendix 004-D.

004.43D 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 004-D.

004.44 Compliance with Environmental and Health Protection Regulations. Nothing in Subsections 004.38, 004.39, 004.40, 004.41, 004.42, or 004.43 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 pursuant to Subsections 004.38, 004.39, 004.40, 004.41, 004.42, or 004.43.

RECORDS

004.45 General Provisions.

004.45A Each licensee or registrant shall use the SI units becquerel, gray, sievert and coulomb per kilogram, or the special units curie, rad, rem, and roentgen, including multiples and subdivisions, and shall clearly indicate the units of all quantities on records required by Section 004.

004.45B Notwithstanding the requirements of 004.45A of this section, when recording information on shipment manifests, as required in 004.43B1, information must be recorded in the International System of Units (SI) or in SI and units as specified in paragraph 004.45A of this section.

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004.45C The licensee or registrant shall make a clear distinction among the quantities entered on the records required by Section 004, such as, total effective dose equivalent, total organ dose equivalent, shallow dose equivalent, eye dose equivalent, deep dose equivalent, or committed effective dose equivalent.

004.46 Records of Radiation Protection Programs.

004.46A Each licensee or registrant shall maintain records of the radiation protection program, including:

004.46A1 The provisions of the program; and

004.46A2 Audits and other reviews of program content and implementation.

004.46B The licensee or registrant shall retain the records required by 004.46A1 until the Agency terminates each pertinent license or registration requiring the record. The licensee or registrant shall retain the records required by 004.46A2 for 3 years after the record is made.

004.47 Records of Surveys.

004.47A Each licensee or registrant shall maintain records showing the results of surveys and calibrations required by 004.22 and 004.37B. The licensee or registrant shall retain these records for 3 years after the record is made.

004.47B The licensee or registrant shall retain each of the following records until the Agency terminates each pertinent license or registration requiring the record:

004.47B1 Records of the results of surveys to determine the dose from external sources of radiation used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents. This includes those records of 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 required under the standards for protection against radiation in effect prior to May 30, 1994; and

004.47B2 Records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose. This includes those records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose required under the standards for protection against radiation in effect prior to May 30, 1994.

004.47B3 Records showing the results of air sampling, surveys, and bioassays required pursuant to 004.29A3a and b. This includes those records showing the results of air sampling, surveys and bioassays required under the standards for protection against radiation in effect prior to May 30, 1994; and

004.47B4 Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment. This includes those records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment required under the standards for protection against radiation in effect prior to May 30, 1994.

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004.48 Records of Tests for Leakage or Contamination of Sealed Sources. Records of tests for leakage or contamination of sealed sources required by 001.11 shall be kept in units of becquerel or microcuries and maintained for inspection by the Agency for 5 years after the records are made.

004.49 Records of Prior Occupational Dose. For each individual who is likely to receive in a year, an occupational dose requiring monitoring pursuant to 004.23 the licensee or registrant shall: Retain the records of prior occupational dose and exposure history as specified in 004.10 on Agency Form NRH-1 or equivalent until the Agency terminates each pertinent license or registration requiring this record. The licensee or registrant shall retain records used in preparing Agency Form NRH-1 for 3 years after the record is made.

004.50 Records of Planned Special Exposures.

004.50A For each use of the provisions of 004.11 for planned special exposures, the licensee or registrant shall maintain records that describe:

004.50A1 The exceptional circumstances requiring the use of a planned special exposure; and

004.50A2 The name of the management official who authorized the planned special exposure and a copy of the signed authorization; and

004.50A3 What actions were necessary; and

004.50A4 Why the actions were necessary; and

004.50A5 What precautions were taken to assure that doses were maintained ALARA; and

004.50A6 What individual and collective doses were expected to result; and

004.50A7 The doses actually received in the planned special exposure.

004.50B The licensee or registrant shall retain the records until the Agency terminates each pertinent license or registration requiring these records.

004.51 Records of Individual Monitoring Results.

004.51A Recordkeeping Requirement. Each licensee or registrant shall maintain records of doses received by all individuals for whom monitoring was required pursuant to 004.23 and records of doses received during planned special exposures, accidents, and emergency conditions. Assessments of dose equivalent and records made using units in effect before the effective date of Section 004 need not be changed. These records shall include, when applicable:

004.51A1 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

004.51A2 The estimated intake of radionuclides, see 004.07; and

004.51A3 The committed effective dose equivalent assigned to the intake of radionuclides; and

004.51A4 The specific information used to calculate the committed effective dose equivalent pursuant to 004.09C; and

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004.51A5 The total effective dose equivalent when required by 004.07; and

004.51A6 The total of the deep dose equivalent and the committed dose to the organ receiving the highest total dose.

004.51B Recordkeeping Frequency. The licensee or registrant shall make entries of the records specified in 004.51A at intervals not to exceed 1 year.

004.51C Recordkeeping Format. The licensee or registrant shall maintain the records specified in 004.51A on Agency Form NRH-2, in accordance with the instructions for Agency Form NRH-2, or in clear and legible records containing all the information required by Agency Form NRH-2.

004.51D The licensee or registrant shall maintain the records of dose to an embryo/fetus with the records of dose to the declared pregnant woman. The declaration of pregnancy, including the estimated date of conception, shall also be kept on file, but may be maintained separately from the dose records.

004.51E The licensee or registrant shall retain each required form or record until the Agency terminates each pertinent license or registration requiring the record.

004.52 Records of Dose to Individual Members of the Public.

004.52A Each licensee or registrant shall maintain records sufficient to demonstrate compliance with the dose limit for individual members of the public. See 004.14.

004.52B The licensee or registrant shall retain the records required by 004.52 until the Agency terminates each pertinent license or registration requiring the record.

004.53 Records of Waste Disposal.

004.53A Each licensee shall maintain records of the disposal of licensed materials made pursuant to 004.39, 004.40, 004.41, 004.42, 012 of these regulations, and disposal by burial in soil, including burials authorized before August 22, 1982.⁴

004.53B The licensee shall retain the records required by 004.53A until the Agency terminates each pertinent license requiring the record. Requirements for disposition of these records, prior to license termination, are located in subsection 003.30 for activities licensed under this subsection. This includes records required under the standards for protection against radiation in effect prior to May 30, 1994.

004.54 Records of Testing Entry Control Devices for Very High Radiation Areas.

004.54A Each licensee or registrant shall maintain records of tests made pursuant to 004.26B8 on entry control devices for very high radiation areas. These records must include the date, time, and results of each such test of function.

⁴A previous 180 NAC 1-004.23, (January 1974) permitted burial of small quantities of licensed material in soil before August 22, 1982, without specific Agency authorization.

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004.54B The licensee or registrant shall retain the records required by 004.54A for 3 years after the record is made.

004.55 Form of Records. Each record required by Section 004 shall be legible throughout the specified retention period. The record shall 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, shall include all pertinent information, such as stamps, initials, and signatures. The licensee or registrant shall maintain adequate safeguards against tampering with and loss of records.

REPORTS

004.56 Reports of Stolen, Lost, or Missing Licensed or Registered Sources of Radiation.

004.56A Telephone Reports. Each licensee or registrant shall report to the Agency by telephone as follows:

004.56A1 Immediately after its occurrence becomes known to the licensee or registrant, stolen, lost, or missing licensed radioactive material in an aggregate quantity equal to or greater than 1,000 times the quantity specified in Appendix 004-C under such circumstances that it appears to the licensee that an exposure could result to individuals in unrestricted areas; or

004.56A2 Within 30 days after its occurrence becomes known to the licensee or registrant, lost, stolen, or missing licensed radioactive material in an aggregate quantity greater than 10 times the quantity specified in Appendix 004-C that is still missing.

004.56A3 Immediately after its occurrence becomes known to the registrant, a stolen, lost, or missing radiation machine.

004.56B Written Reports. Each licensee or registrant required to make a report pursuant to 004.56A shall, within 30 days after making the telephone report, make a written report to the Agency setting forth the following information:

004.56B1 A description of the licensed or registered source of radiation involved, including, for radioactive material, the kind, quantity, and chemical and physical form; and, for radiation machines, the manufacturer, model and serial number, type and maximum energy of radiation emitted;

004.56B2 A description of the circumstances under which the loss or theft occurred; and

004.56B3 A statement of disposition, or probable disposition, of the licensed or registered source of radiation involved; and

004.56B4 Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas; and

004.56B5 Actions that have been taken, or will be taken, to recover the source of radiation; and

004.56B6 Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed or registered sources of radiation.

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004.56C Subsequent to filing the written report, the licensee or registrant shall also report additional substantive information on the loss or theft within 30 days after the licensee or registrant learns of such information.

004.56D The licensee or registrant shall prepare any report filed with the Agency pursuant to 004.56 so that names of individuals who may have received exposure to radiation are stated in a separate and detachable portion of the report.

004.57 Notification of Incidents.

004.57A Immediate Notification. Notwithstanding other requirements for notification, each licensee or registrant shall immediately report each event involving a source of radiation possessed by the licensee or registrant that may have caused or threatens to cause any of the following conditions:

004.57A1 An individual to receive:

004.57A1a A total effective dose equivalent of 0.25 Sv (25 rem) or more; or

004.57A1b An eye dose equivalent of 0.75 Sv (75 rem) or more; or

004.57A1c A shallow dose equivalent to the skin or extremities of 2.5 Gy (250 rad) or more;
or

004.57A2 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 ALI. This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.

004.57B Twenty-Four Hour Notification. Each licensee or registrant shall, within 24 hours of discovery of the event, report to the Agency each event involving loss of control of a licensed or registered source of radiation possessed by the licensee or registrant that may have caused, or threatens to cause, any of the following conditions:

004.57B1 An individual to receive, in a period of 24 hours:

004.57B1a A total effective dose equivalent exceeding 0.05 Sv (5 rem); or

004.57B1b An eye dose equivalent exceeding 0.15 Sv (15 rem); or

004.57B1c A shallow dose equivalent to the skin or extremities exceeding 0.5 Sv (50 rem);
or

004.57B2 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 ALI. This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures).

004.57C The licensee or registrant shall prepare each report filed with the Agency pursuant to 004.57 so that names of individuals who have received exposure to sources of radiation are stated in a separate and detachable portion of the report.

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004.57D Licensees or registrants shall make the reports required by 004.57A and B by initial contact by telephone to the Agency and shall confirm the initial contact by telegram, mailgram, or electronic media to the Agency.

004.57E The provisions of 004.57 do not apply to doses that result from planned special exposures, provided such doses are within the limits for planned special exposures and are reported pursuant to 004.59.

004.58 Reports of Exposures, Radiation Levels, and Concentrations of Radioactive Material Exceeding the Constraints or Limits.

004.58A Reportable Events. In addition to the notification required by 004.57, each licensee or registrant shall submit a written report within 30 days after learning of any of the following occurrences:

004.58A1 Any incident for which notification is required by 004.57; or

004.58A2 Doses in excess of any of the following:

004.58A2a The occupational dose limits for adults in 004.06; or

004.58A2b The occupational dose limits for a minor in 004.12; or

004.58A2c The limits for an embryo/fetus of a declared pregnant woman in 004.13; or

004.58A2d The limits for an individual member of the public in 004.14; or

004.58A2e Any applicable limit in the license; or

004.58A2f The ALARA constraints for air emissions established under 004.05D; or

004.58A3 Levels of radiation or concentrations of radioactive material in:

004.58A3a A restricted area in excess of applicable limits in the license; or

004.58A3b An unrestricted area in excess of 10 times the applicable limit set forth in Section 004 or in the license, whether or not involving exposure of any individual in excess of the limits in 004.14; or

004.58A4 For licensees subject to the provisions of U.S. Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190, incorporated herein by reference and available for viewing at the Department of Health and Human Services Regulation and Licensure, 301 Centennial Mall South, 3rd floor, Lincoln, Nebraska 68509-5007, levels of radiation or releases of radioactive material in excess of those standards, or of license conditions related to those standards.

004.58B Contents of Reports.

004.58B1 Each report required by 004.58 shall describe the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:

004.58B1a Estimates of each individual's dose; and

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004.58B1b The levels of radiation and concentrations of radioactive material involved; and

004.58B1c The cause of the elevated exposures, dose rates, or concentrations; and

004.58B1d Corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, ALARA constraints, generally applicable environmental standards and associated license conditions.

004.58B2 Each report filed pursuant to 004.58A shall include for each individual exposed: the name, Social Security account number, and date of birth. With respect to the limit for the embryo fetus in 004.13, the identifiers should be those of the declared pregnant woman. The report shall be prepared so that this information is stated in a separate and detachable portion of the report.

004.58C All licensees or registrants who make reports pursuant to 004.58A shall submit the report in writing to the Agency.

004.59 Reports of Planned Special Exposures. The licensee or registrant shall submit a written report to the Agency within 30 days following any planned special exposure conducted in accordance with 004.11, informing the Agency that a planned special exposure was conducted and indicating the date the planned special exposure occurred and the information required by 004.50.

004.60 [Reserved]

004.61 Reports of Individual Monitoring.

004.61A This section applies to each person licensed by the Agency to:

004.61A1 Possess or use sources of radiation for purposes of industrial radiography pursuant to Sections 003 and 005 of these regulations; or

004.61A2 Receive radioactive waste from other persons for disposal pursuant to Section 012 of these regulations; or

004.61A3 Possess or use at any time, for processing or manufacturing for distribution pursuant to Sections 003 or 007 of these regulations, radioactive material in quantities exceeding any one of the following quantities:

Radionuclide	Activity^a	
	Ci	GBq
Cesium-137	1	37
Cobalt-60	1	37
Gold-198	100	3,700
Iodine-131	1	37
Iridium-192	10	370
Krypton-85	1,000	37,000
Promethium	10	370
Technetium-99m	1,000	37,000

^aThe Agency may require as a license condition, or by rule, regulation, or order pursuant to 001.07, reports from licensees who are licensed to use radionuclides not on this list, in quantities sufficient to cause comparable radiation levels.

004.61B Each licensee in a category listed in 004.61A 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 004.23 during that year. The licensee may include additional data for individuals for whom monitoring was provided but not required. The licensee shall use Agency Form NRH-2 or electronic media containing all the information required by Agency Form NRH-2.

004.61C The licensee shall file the report required by 004.61B, covering the preceding year, on or before April 30 of each year. The licensee or registrant shall submit the report to the Agency.

004.62 Notifications and Reports to Individuals.

004.62A Requirements for notification and reports to individuals of exposure to radiation or radioactive material are specified in 010.04 of these regulations.

004.62B When a licensee or registrant is required, pursuant to the provisions of 004.58, 004.59 and 004.61, to report to the Agency any exposure of identified occupationally exposed individual, or an identified member of the public, to radiation or radioactive material, the licensee shall also provide a copy of the report submitted to the Agency to the individual. This report must be transmitted at a time no later than the transmittal to the Agency.

004.63 Reports of Leaking or Contaminated Sealed Sources. The licensee shall file a report within 5 days with the Agency if the test for leakage or contamination required pursuant to 001.11 indicates a sealed source is leaking or contaminated. The report shall include the equipment involved, the test results and the corrective action taken.

ADDITIONAL REQUIREMENTS

004.64 Vacating Premises. Each specific licensee shall, no less than 30 days before vacating or relinquishing possession or control of premises which may have been contaminated with radioactive material as a result of his activities, notify the Agency in writing of intent to vacate. When deemed necessary by the Agency, the licensee shall decontaminate the premises in such a manner as the Agency may specify.

APPENDIX 004-A

PROTECTION FACTORS FOR RESPIRATORS¹

Description ²	Modes ³	Protection Factors ⁴		Tested and Certified Equipment
		Particu- lates Only	Particu- lates, gases, & vapors ⁵	
I. AIR-PURIFYING RESPIRATORS:⁶				
Facepiece, half-mask ⁷	NP	10	—	30 CFR 11,
Facepiece, full	NP	50	—	Subpart K.
Facepiece, half-mask full or hood	PP	1000	—	
II. ATMOSPHERE-SUPPLYING RESPIRATORS				
1. Air-line Respirator:				
Facepiece, half-mask	CF	—	1000	30 CFR 11,
Facepiece, half-mask	D	—	5	Subpart J.
Facepiece, full	CF	—	2000	
Facepiece, full	D	—	5	
Facepiece, full	PD	—	2000	
Hood	CF	—		⁸
Suit	CF	—		⁹ ¹⁰
2. Self-contained breathing apparatus (SCBA):				
Facepiece, full	D	—	50	30 CFR 11,
Facepiece, full	PD	—	10,000 ¹¹	Subpart H.
Facepiece, full	RD	—	50	
Facepiece, full	RP	—	5,000 ¹²	
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 11, Sec. 11.63(b).

See next page for footnotes.

FOOTNOTES

1. For use in the selection of respiratory protective equipment to be used only where the contaminants have been identified and the concentrations, or possible concentrations, are known.
2. Only for shaven faces and where nothing interferes with the seal of tight-fitting facepieces against the skin. Hoods and suits are excepted.
3. The mode symbols are defined as follows:
 - CF = continuous flow
 - D = demand
 - NP = negative pressure, that is, negative phase during inhalation
 - PD = pressure demand, that is, always positive pressure
 - PP = positive pressure
 - RD = demand, recirculating (closed circuit)
 - RP = pressure demand, recirculating (closed circuit)

4. a. 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:

$$\text{Concentration inhaled} = \frac{\text{Ambient airborne concentration}}{\text{Protection factor}}$$

- b. The protection factors apply:
 - (i) 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.
 - (ii) 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.
 - (iii) No adjustment is to be made for the use of sorbents against radioactive material in the form of gases or vapors.
 - (iv) 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 the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration certification as described in 30 CFR 11. Oxygen and air shall not be used in the same apparatus.
5. 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 respiratory protective equipment is 5, the effective protection factor for tritium is about 1.4; with protection factors of 10, the effective factor for tritium oxide is about 1.7; and 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 9 concerning supplied-air suits.
6. Canisters and cartridges shall not be used beyond service-life limitations.

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7. 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 I, Column 3 of Appendix 004-B of Section 004. 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.
8.
 - a. 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 per minute (0.17 m³/min) 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 per minute (0.17m³/min) and calibrated air line pressure gauges or flow measuring devices are used.
 - b. The design of the supplied-air hood or helmet, with a minimum flow of 6 cubic feet per minute (0.17 m³/min) 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 9.
9. 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.
10. No approval schedules are currently available for this equipment. Equipment is to be evaluated by testing or on the basis of reliable test information.
11. 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.
12. 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 approved by the U.S. Bureau of Mines and the National Institute for Occupational Safety and Health, 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 and the National Institute for Occupational Safety and Health.

Note 2: Radioactive contaminants, for which the concentration values in Table I, Column 3 of Appendix 004-B of Section 004 are based on internal dose due to inhalation, may present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.

APPENDIX 004-B

ANNUAL LIMITS ON INTAKE (ALI) AND DERIVED AIR CONCENTRATIONS
(DAC) OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT CONCENTRATIONS;
CONCENTRATIONS FOR RELEASE TO SANITARY SEWERAGE

Introduction

For each radionuclide, Table I 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 , micron, 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 for D if less than 10 days, for W from 10 to 100 days, and for Y greater than 100 days. The class (D,W, or Y) given in the column headed "Class" applies only to the inhalation ALIs and DACs given in Table I, columns 2 and 3. Table II provides concentration limits for airborne and liquid effluents released to the general environment. Table III provides concentration limits for discharges to sanitary sewerage.

Note: The values in Tables I, II, and III 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 I "Occupational Values"

Note that the columns in Table I 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 given radionuclide by "Reference Man" which would result in either (1) a committed effective dose equivalent of 0.05 Sv (5 rem), stochastic ALI, or (2) a committed dose equivalent of 0.5 Sv (50 rem) 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 0.05 Sv (5 rem). 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 004.03. 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 portions 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 an extremity, 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:

- LLI wall = lower large intestine wall;
- St. wall = stomach wall;

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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 nonstochastic 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 0.5 Sv (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 equivalent 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}) that contribute to the committed dose equivalent to the organ receiving the highest dose does not exceed unity, that is, $\sum (\text{intake (in } \mu\text{Ci)}) / ALI_{ns} \leq 1.0$. 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 ≤ 1.0 .

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:

$$\text{DAC} = \text{ALI (in } \mu\text{Ci)} / (2000 \text{ hours per working year} \times 60 \text{ minutes/hour} \times 2 \times 10^4 \text{ ml per minute}) = [\text{ALI} / 2.4 \times 10^9] \mu\text{Ci/ml},$$

where 2×10^4 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. DACs 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 include contributions to exposure by the single radionuclide named and any in-growth of daughter radionuclides produced in the body by 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 values 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 irradiation. See Sec. 004.07. When an individual is exposed to radioactive materials which fall under several of the translocation classifications of the same radionuclide, such as, Class D, Class W, or Class Y, 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 radionuclides. For this reason, values are given for Class D, W, and Y compounds, even for very short-lived radionuclides.

Table II "Effluent Concentrations"

The columns in Table II 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 004.15. The concentration values given in Columns 1 and 2 of Table II 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 0.5 mSv (0.05 rem).

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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 or below 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 II. For this reason, the DAC and airborne effluent limits are not always proportional as was the case in Appendix 1 of Section 004 of Title 180 NAC 1 (Nebraska Regulations for Control of Radiation-Ionizing) which went into effect on 11-25-90.

The air concentration values listed in Table II, 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 2.4×10^9 ml, 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 0.05 Sv (5 rem) annual occupational dose limit to the 1 mSv (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 I, 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 7.3×10^7 . The factor of 7.3×10^7 (ml) includes the following components: the factors of 50 and 2 described above and a factor of 7.3×10^5 (ml) which is the annual water intake of Reference Man.

Note 2 at the end 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 releases to sewer, require demonstrating that the most limiting radionuclides in successive classes are absent. The limit for the unknown mixture is defined when the presence of 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 III "Releases to Sewers"

The monthly average concentrations for release to sanitary sewerage are applicable to the provisions in 004.40. The concentration values were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^6 (ml). The factor of 7.3×10^6 (ml) is composed of a factor of 7.3×10^5 (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 mSv (0.5 rem).

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LIST OF ELEMENTS

Name	Atomic Symbol	Atomic Number	Name	Atomic Symbol	Atomic Number
Actinium	Ac	89	Mercury	Hg	80
Aluminum	Al	13	Molybdenum	Mo	42
Americium	Am	95	Neodymium	Nd	60
Antimony	Sb	51	Neptunium	Np	93
Argon	Ar	18	Nickel	Ni	28
Arsenic	As	33	Niobium	Nb	41
Astatine	At	85	Osmium	Os	76
Barium	Ba	56	Palladium	Pd	46
Berkelium	Bk	97	Phosphorus	P	15
Beryllium	Be	4	Platinum	Pt	78
Bismuth	Bi	83	Plutonium	Pu	94
Bromine	Br	35	Polonium	Po	84
Cadmium	Cd	48	Potassium	K	19
Calcium	Ca	20	Praseodymium	Pr	59
Californium	Cf	98	Promethium	Pm	61
Carbon	C	6	Protactinium	Pa	91
Cerium	Ce	58	Radium	Ra	88
Cesium	Cs	55	Radon	Rn	86
Chlorine	Cl	17	Rhenium	Re	75
Chromium	Cr	24	Rhodium	Rh	45
Cobalt	Co	27	Rubidium	Rb	37
Copper	Cu	29	Ruthenium	Ru	44
Curium	Cm	96	Samarium	Sm	62
Dysprosium	Dy	66	Scandium	Sc	21
Einsteinium	Es	99	Selenium	Se	34
Erbium	Er	68	Silicon	Si	14
Europium	Eu	63	Silver	Ag	47
Fermium	Fm	100	Sodium	Na	11
Fluorine	F	9	Strontium	Sr	38
Francium	Fr	87	Sulfur	S	16
Gadolinium	Gd	64	Tantalum	Ta	73
Gallium	Ga	31	Technetium	Tc	43
Germanium	Ge	32	Tellurium	Te	52
Gold	Au	79	Terbium	Tb	65
Hafnium	Hf	72	Thallium	Tl	81
Holmium	Ho	67	Thorium	Th	90
Hydrogen	H	1	Thulium	Tm	69
Indium	In	49	Tin	Sn	50
Iodine	I	53	Titanium	Ti	22
Iridium	Ir	77	Tungsten	W	74
Iron	Fe	26	Uranium	U	92
Krypton	Kr	36	Vanadium	V	23
Lanthanum	La	57	Xenon	Xe	54
Lead	Pb	82	Ytterbium	Yb	70
Lutetium	Lu	71	Yttrium	Y	39
Magnesium	Mg	12	Zinc	Zn	30
Manganese	Mn	25	Zirconium	Zr	40
Mendelevium	Md	101			

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 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 ($\mu\text{Ci}/\text{ml}$)
1	Hydrogen-3	Water, DAC includes skin absorption	8E+4	8E+4	2E-5	1E-7	1E-3	1E-2
		Gas (HT or T ₂) Submersion ¹ : Use above values as HT and T ₂ oxidize in air and in the body to HTO.						
4	Beryllium-7	W, all compounds except those given for Y	4E+4	2E+4	9E-6	3E-8	6E-4	6E-3
		Y, oxides, halides, and nitrates	-	2E+4	8E-6	3E-8	-	-
4	Beryllium-10	W, see ⁷ Be	1E+3	2E+2	6E-8	2E-10	-	-
		LLI wall (1E+3)	-	-	-	-	2E-5	2E-4
		Y, see ⁷ Be	-	1E+1	6E-9	2E-11	-	-
6	Carbon-11 ²	Monoxide	-	1E+6	5E-4	2E-6	-	-
		Dioxide	-	6E+5	3E-4	9E-7	-	-
		Compounds	4E+5	4E+5	2E-4	6E-7	6E-3	6E-2
6	Carbon-14	Monoxide	-	2E+6	7E-4	2E-6	-	-
		Dioxide	-	2E+5	9E-5	3E-7	-	-
		Compounds	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
9	Fluorine-18 ²	D, fluorides of H, Li, Na, K, Rb, Cs, and Fr	5E+4	7E+4	3E-5	1E-7	-	-
		St wall (5E+4)	-	-	-	-	7E-4	7E-3
		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	-	9E+4	4E-5	1E-7	-	-
		Y, lanthanum fluoride	-	8E+4	3E-5	1E-7	-	-
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	7E+2	2E+3	7E-7	2E-9	9E-6	9E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	1E+3	5E-7	2E-9	-	-
13	Aluminum-26	D, all compounds except those given for W	4E+2	6E+1	3E-8	9E-11	6E-6	6E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	9E+1	4E-8	1E-10	-	-
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	2E+2	1E-7	3E-10	-	-
		LLI wall (3E+3)	-	-	-	-	4E-5	4E-4
		W, see ³¹ Si	-	1E+2	5E-8	2E-10	-	-
		Y, see ³¹ Si	-	5E+0	2E-9	7E-12	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μ Ci)	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μ Ci/ml)
				Inhalation		Air (μ Ci/ml)	Water (μ Ci/ml)	
		ALI (μ Ci)	DAC (μ Ci/ml)					
15	Phosphorus-32	D, all compounds except phosphates given for W W, phosphates of Zn ²⁺ , S ³⁺ , Mg ²⁺ , Fe ³⁺ , Bi ³⁺ , and lanthanides	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
			-	4E+2	2E-7	5E-10	-	-
15	Phosphorus-33	D, see ³² P W, see ³² P	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4
			-	3E+3	1E-6	4E-9	-	-
16	Sulfur-35	Vapor D, sulfides and sulfates except those given for W	-	1E+4	6E-6	2E-8	-	-
			1E+4	2E+4	7E-6	2E-8	-	-
		LLI wall (8E+3)	-	-	-	1E-4	1E-3	
		6E+3	-	-	-	-	-	
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr 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+3	2E+3	1E-6	3E-9	2E-5	2E-4
			-	2E+2	1E-7	3E-10	-	-
17	Chlorine-38 ²	D, see ³⁶ Cl W, see ³⁶ Cl	2E+4	4E+4	2E-5	6E-8	-	-
			St wall (3E+4)	-	-	-	3E-4	3E-3
17	Chlorine-39 ²	D, see ³⁶ Cl W, see ³⁶ Cl	2E+4	5E+4	2E-5	7E-8	-	-
			St wall (4E+4)	-	-	-	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	6E-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	7E+4	3E-5	9E-8	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
19	Potassium-45 ²	D, all compounds	3E+4	1E+5	5E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
20	Calcium-41	W, all compounds	3E+3	4E+3	2E-6	-	-	-
			Bone surf	Bone surf				

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			(4E+3)	(4E+3)	-	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-44m	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	-	-
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 W, oxides, hydroxides, carbides, halides, and nitrates Y, SrTiO	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
			-	3E+1	1E-8	4E-11	-	-
			-	6E+0	2E-9	8E-12	-	-
	Titanium-45	D, see ⁴⁴ Ti W, see ⁴⁴ Ti Y, see ⁴⁴ Ti	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 W, oxides, hydroxides, carbides, and halides	3E+4 St wall (3E+4)	8E+4	3E-5	1E-7	-	-
			-	-	-	-	4E-4	4E-3
			-	1E+5	4E-5	1E-7	-	-
23	Vanadium-48	D, see ⁴⁷ V W, see ⁴⁷ V	6E+2	1E+3	5E-7	2E-9	9E-6	9E-5
			-	6E+2	3E-7	9E-10	-	-
23	Vanadium-49	D, see ⁴⁷ V W, see ⁴⁷ V	7E+4 LLI wall (9E+4)	3E+4 Bone surf (3E+4)	1E-5	-	-	-
			-	2E+4	8E-6	5E-8 2E-8	1E-3	1E-2
			-	-	-	-	-	-
24	Chromium-48	D, all compounds except those given for W and Y W, halides and nitrates Y, oxides and hydroxides	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
			-	7E+3	3E-6	1E-8	-	-
			-	7E+3	3E-6	1E-8	-	-
24	Chromium-49 ²	D, see ⁴⁸ Cr W, see ⁴⁸ Cr Y, see ⁴⁸ Cr	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 ⁴⁸ Cr W, see ⁴⁸ Cr Y, see ⁴⁸ Cr	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 W, oxides, hydroxides, halides, and nitrates	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
			-	6E+4	3E-5	8E-8	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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 ($\mu\text{Ci}/\text{ml}$)			
25	Manganese-52m ²	D, see ⁵¹ Mn	3E+4	9E+4	4E-5	1E-7	-	-
		St wall (4E+4)	-	-	-	-	5E-4	5E-3
		W, see ⁵¹ Mn	-	1E+5	4E-5	1E-7	-	-
25	Manganese-52	D, see ⁵¹ Mn	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
		W, see ⁵¹ Mn	-	9E+2	4E-7	1E-9	-	-
25	Manganese-53	D, see ⁵¹ Mn	5E+4	1E+4	5E-6	-	7E-4	7E-3
		W, see ⁵¹ Mn	-	Bone surf (2E+4)	-	3E-8	-	-
			-	1E+4	5E-6	2E-8	-	-
25	Manganese-54	D, see ⁵¹ Mn	2E+3	9E+2	4E-7	1E-9	3E-5	3E-4
		W, see ⁵¹ Mn	-	8E+2	3E-7	1E-9	-	-
25	Manganese-56	D, see ⁵¹ Mn	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ⁵¹ Mn	-	2E+4	9E-6	3E-8	-	-
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	9E+3	2E+3	8E-7	3E-9	1E-4	1E-3
		W, see ⁵² Fe	-	4E+3	2E-6	6E-9	-	-
26	Iron-59	D, see ⁵² Fe	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		W, see ⁵² Fe	-	5E+2	2E-7	7E-10	-	-
26	Iron-60	D, see ⁵² Fe	3E+1	6E+0	3E-9	9E-12	4E-7	4E-6
		W, see ⁵² Fe	-	2E+1	8E-9	3E-11	-	-
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 ⁵⁶ Co	5E+2	3E+2	1E-7	4E-10	6E-6	6E-5
		Y, see ⁵⁶ Co	4E+2	2E+2	8E-8	3E-10	-	-
27	Cobalt-57	W, see ⁵⁶ Co	8E+3	3E+3	1E-6	4E-9	6E-5	6E-4
		Y, see ⁵⁶ Co	4E+3	7E+2	3E-7	9E-10	-	-
27	Cobalt-58m	W, see ⁵⁶ Co	6E+4	9E+4	4E-5	1E-7	8E-4	8E-3
		Y, see ⁵⁶ Co	-	6E+4	3E-5	9E-8	-	-
27	Cobalt-58	W, see ⁵⁶ Co	2E+3	1E+3	5E-7	2E-9	2E-5	2E-4
		Y, see ⁵⁶ Co	1E+3	7E+2	3E-7	1E-9	-	-
27	Cobalt-60m ²	W, see ⁵⁶ Co	1E+6	4E+6	2E-3	6E-6	-	-
		St wall (1E+6)	-	-	-	-	2E-2	2E-1
		Y, see ⁵⁶ Co	-	3E+6	1E-3	4E-6	-	-
27	Cobalt-60	W, see ⁵⁶ Co	5E+2	2E+2	7E-8	2E-10	3E-6	3E-5
		Y, see ⁵⁶ Co	2E+2	3E+1	1E-8	5E-11	-	-
27	Cobalt-61 ²	W, see ⁵⁶ Co	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ⁵⁶ Co	2E+4	6E+4	2E-5	8E-8	-	-
27	Cobalt-62m ²	W, see ⁵⁶ Co	4E+4	2E+5	7E-5	2E-7	-	-
		St wall (5E+4)	-	-	-	-	7E-4	7E-3

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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				
			ALI (μCi)	DAC ($\mu\text{Ci}/\text{ml}$)				
		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	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
		W, see ^{56}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	6E+3	3E-6	9E-9	-	-
28	Nickel-59	D, see ^{56}Ni	2E+4	4E+3	2E-6	5E-9	3E-4	3E-3
		W, see ^{56}Ni	-	7E+3	3E-6	1E-8	-	-
		Vapor	-	2E+3	8E-7	3E-9	-	-
28	Nickel-63	D, see ^{56}Ni	9E+3	2E+3	7E-7	2E-9	1E-4	1E-3
		W, see ^{56}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	8E+2	3E-7	1E-9	-	-
28	Nickel-65	D, see ^{56}Ni	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{56}Ni	-	3E+4	1E-5	4E-8	-	-
		Vapor	-	2E+4	7E-6	2E-8	-	-
28	Nickel-66	D, see ^{56}Ni	4E+2	2E+3	7E-7	2E-9	-	-
		LLI wall (5E+2)	-	-	-	-	6E-6	6E-5
		W, see ^{56}Ni	-	6E+2	3E-7	9E-10	-	-
		Vapor	-	3E+3	1E-6	4E-9	-	-
29	Copper-60 ²	D, all compounds except those given for W and Y	3E+4	9E+4	4E-5	1E-7	-	-
		St wall (3E+4)	-	-	-	-	4E-4	4E-3
		W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	4E-5	1E-7	-	-
29	Copper-61	D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{60}Cu	-	4E+4	2E-5	6E-8	-	-
		Y, see ^{60}Cu	-	4E+4	1E-5	5E-8	-	-
29	Copper-64	D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{60}Cu	-	2E+4	1E-5	3E-8	-	-
		Y, see ^{60}Cu	-	2E+4	9E-6	3E-8	-	-
29	Copper-67	D, see ^{60}Cu	5E+3	8E+3	3E-6	1E-8	6E-5	6E-4
		W, see ^{60}Cu	-	5E+3	2E-6	7E-9	-	-
		Y, see ^{60}Cu	-	5E+3	2E-6	6E-9	-	-
30	Zinc-62	Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
30	Zinc-63 ²	Y, all compounds	2E+4	7E+4	3E-5	9E-8	-	-
		St wall (3E+4)	-	-	-	-	3E-4	3E-3
30	Zinc-65	Y, all compounds	4E+2	3E+2	1E-7	4E-10	5E-6	5E-5
30	Zinc-69m	Y, all compounds	4E+3	7E+3	3E-6	1E-8	6E-5	6E-4
30	Zinc-69 ²	Y, all compounds	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
30	Zinc-71m	Y, all compounds	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
	Zinc-72	Y, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci/ml}$)
				Inhalation		Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	
		ALI (μCi)	DAC ($\mu\text{Ci/ml}$)					
31	Gallium-65 ²	D, all compounds except those given for W	5E+4 St wall (6E+4)	2E+5	7E-5	2E-7	-	-
		W, oxides, hydroxides, carbides, halides, and nitrates	-	2E+5	8E-5	3E-7	9E-4	9E-3
31	Gallium-66	D, see ⁶⁵ Ga W, see ⁶⁵ Ga	1E+3 -	4E+3 3E+3	1E-6 1E-6	5E-9 4E-9	1E-5 -	1E-4 -
31	Gallium-67	D, see ⁶⁵ Ga W, see ⁶⁵ Ga	7E+3 -	1E+4 1E+4	6E-6 4E-6	2E-8 1E-8	1E-4 -	1E-3 -
31	Gallium-68 ²	D, see ⁶⁵ Ga W, see ⁶⁵ Ga	2E+4 -	4E+4 5E+4	2E-5 2E-5	6E-8 7E-8	2E-4 -	2E-3 -
31	Gallium-70 ²	D, see ⁶⁵ Ga W, see ⁶⁵ Ga	5E+4 St wall (7E+4) -	2E+5 -	7E-5 -	2E-7 -	- 1E-3	- 1E-2
31	Gallium-72	D, see ⁶⁵ Ga W, see ⁶⁵ Ga	1E+3 -	4E+3 3E+3	1E-6 1E-6	5E-9 4E-9	2E-5 -	2E-4 -
31	Gallium-73	D, see ⁶⁵ Ga W, see ⁶⁵ Ga	5E+3 -	2E+4 2E+4	6E-6 6E-6	2E-8 2E-8	7E-5 -	7E-4 -
32	Germanium-66	D, all compounds except those given for W W, oxides, sulfides, and halides	2E+4 -	3E+4 2E+4	1E-5 8E-6	4E-8 3E-8	3E-4 -	3E-3 -
32	Germanium-67 ²	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	3E+4 St wall (4E+4) -	9E+4 1E+5	4E-5 4E-5	1E-7 1E-7	- 6E-4	- 6E-3
32	Germanium-68	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	5E+3 -	4E+3 1E+2	2E-6 4E-8	5E-9 1E-10	6E-5 -	6E-4 -
32	Germanium-69	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	1E+4 -	2E+4 8E+3	6E-6 3E-6	2E-8 1E-8	2E-4 -	2E-3 -
32	Germanium-71	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	5E+5 -	4E+5 4E+4	2E-4 2E-5	6E-7 6E-8	7E-3 -	7E-2 -
32	Germanium-75 ²	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	4E+4 St wall (7E+4) -	8E+4 8E+4	3E-5 4E-5	1E-7 1E-7	- 9E-4	- 9E-3
32	Germanium-77	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	9E+3 -	1E+4 6E+3	4E-6 2E-6	1E-8 8E-9	1E-4 -	1E-3 -
32	Germanium-78 ²	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	2E+4 St wall (2E+4) -	2E+4 2E+4	9E-6 9E-6	3E-8 3E-8	- 3E-4	- 3E-3
33	Arsenic-69 ²	W, all compounds	3E+4 St wall (4E+4)	1E+5	5E-5	2E-7	- 6E-4	- 6E-3

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
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	2E-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	5E+3	2E-6	7E-9	-	-
			LLI wall (5E+3)	-	-	-	6E-5	6E-4
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
			1E+4	4E+4	2E-5	6E-8	-	-
34	Selenium-73m 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-81m 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 -
35	Bromine-74m ²	D, bromides of H, Li, Na, K, Rb, Cs, and Fr W, bromides 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, Mn, Tc, and Re	1E+4 St wall (2E+4) -	4E+4 -	2E-5 -	5E-8 -	- 3E-4	- 3E-3
35	Bromine-74 ²	D, see ^{74m} Br W, see ^{74m} Br	2E+4 St wall (4E+4) -	7E+4 -	3E-5 -	1E-7 -	- 5E-4	- 5E-3

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
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	-	-
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	5E-5	2E-7	-	-
			-	-	-	-	8E-4	8E-3
37	Rubidium-81m ²	D, all compounds	2E+5 St wall (3E+5)	3E+5	1E-4	5E-7	-	-
			-	-	-	-	4E-3	4E-2
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

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
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 -	- 4E-4	- 4E-3
37	Rubidium-89 ²	D, all compounds	4E+4 St wall (6E+4)	1E+5 -	6E-5 -	2E-7 -	- 9E-4	- 9E-3
38	Strontium-80 ²	D, all soluble compounds except SrTiO ₃	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		Y, all insoluble compounds and SrTiO ₃	-	1E+4	5E-6	2E-8	-	-
38	Strontium-81 ²	D, see ⁸⁰ Sr	3E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ⁸⁰ Sr	2E+4	8E+4	3E-5	1E-7	-	-
38	Strontium-82	D, see ⁸⁰ Sr	3E+2 LLI wall (2E+2)	4E+2 -	2E-7 -	6E-10 -	- 3E-6	- 3E-5
		Y, see ⁸⁰ Sr	2E+2	9E+1	4E-8	1E-10	-	-
38	Strontium-83	D, see ⁸⁰ Sr	3E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ⁸⁰ Sr	2E+3	4E+3	1E-6	5E-9	-	-
38	Strontium-85m ²	D, see ⁸⁰ Sr	2E+5	6E+5	3E-4	9E-7	3E-3	3E-2
		Y, see ⁸⁰ Sr	-	8E+5	4E-4	1E-6	-	-
38	Strontium-85	D, see ⁸⁰ Sr	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
		Y, see ⁸⁰ Sr	-	2E+3	6E-7	2E-9	-	-
38	Strontium-87m	D, see ⁸⁰ Sr	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ⁸⁰ Sr	4E+4	2E+5	6E-5	2E-7	-	-
38	Strontium-89	D, see ⁸⁰ Sr	6E+2 LLI wall (6E+2)	8E+2 -	4E-7 -	1E-9 -	- 8E-6	- 8E-5
		Y, see ⁸⁰ Sr	5E+2	1E+2	6E-8	2E-10	-	-
38	Strontium-90	D, see ⁸⁰ Sr	3E+1 Bone surf (4E+1)	2E+1 Bone surf (2E+1)	8E-9 -	- 3E-11	- 5E-7	- 5E-6
		Y, see ⁸⁰ Sr	-	4E+0	2E-9	6E-12	-	-
38	Strontium-91	D, see ⁸⁰ Sr	2E+3	6E+3	2E-6	8E-9	2E-5	2E-4
		Y, see ⁸⁰ Sr	-	4E+3	1E-6	5E-9	-	-
38	Strontium-92	D, see ⁸⁰ Sr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ⁸⁰ Sr	-	7E+3	3E-6	9E-9	-	-
39	Yttrium-86m ²	W, all compounds except those given for Y	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		Y, oxides and hydroxides	-	5E+4	2E-5	8E-8	-	-
39	Yttrium-86	W, see ^{86m} Y	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ^{86m} Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-87	W, see ^{86m} Y	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		Y, see ^{86m} Y	-	3E+3	1E-6	5E-9	-	-

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Atomic Radionuclide No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
39	Yttrium-88	W, see ^{86m} Y Y, see ^{86m} Y	1E+3 -	3E+2 2E+2	1E-7 1E-7	3E-10 3E-10	1E-5 -	1E-4 -
39	Yttrium-90m	W, see ^{86m} Y Y, see ^{86m} Y	8E+3 -	1E+4 1E+4	5E-6 5E-6	2E-8 2E-8	1E-4 -	1E-3 -
39	Yttrium-90	W, see ^{86m} Y Y, see ^{86m} Y	4E+2 LLI wall (5E+2) -	7E+2 - 6E+2	3E-7 - 3E-7	9E-10 - 9E-10	- 7E-6 -	- 7E-5 -
39	Yttrium-91m ²	W, see ^{86m} Y Y, see ^{86m} Y	1E+5 -	2E+5 2E+5	1E-4 7E-5	3E-7 2E-7	2E-3 -	2E-2 -
39	Yttrium-91	W, see ^{86m} Y Y, see ^{86m} Y	5E+2 LLI wall (6E+2) -	2E+2 - 1E+2	7E-8 - 5E-8	2E-10 - 2E-10	- 8E-6 -	- 8E-5 -
39	Yttrium-92	W, see ^{86m} Y Y, see ^{86m} Y	3E+3 -	9E+3 8E+3	4E-6 3E-6	1E-8 1E-8	4E-5 -	4E-4 -
39	Yttrium-93	W, see ^{86m} Y Y, see ^{86m} Y	1E+3 -	3E+3 2E+3	1E-6 1E-6	4E-9 3E-9	2E-5 -	2E-4 -
39	Yttrium-94 ²	W, see ^{86m} Y Y, see ^{86m} Y	2E+4 St wall (3E+4) -	8E+4 - 8E+4	3E-5 - 3E-5	1E-7 - 1E-7	- 4E-4 -	- 4E-3 -
39	Yttrium-95 ²	W, see ^{86m} Y Y, see ^{86m} Y	4E+4 St wall (5E+4) -	2E+5 - 1E+5	6E-5 - 6E-5	2E-7 - 2E-7	- 7E-4 -	- 7E-3 -
40	Zirconium-86	D, all compounds except those given for W and Y W, oxides, hydroxides, halides, and nitrates Y, carbide	1E+3 - -	4E+3 3E+3 2E+3	2E-6 1E-6 1E-6	6E-9 4E-9 3E-9	2E-5 - -	2E-4 - -
40	Zirconium-88	D, see ⁸⁶ Zr W, see ⁸⁶ Zr Y, see ⁸⁶ Zr	4E+3 - -	2E+2 5E+2 3E+2	9E-8 2E-7 1E-7	3E-10 7E-10 4E-10	5E-5 - -	5E-4 - -
40	Zirconium-89	D, see ⁸⁶ Zr W, see ⁸⁶ Zr Y, see ⁸⁶ Zr	2E+3 - -	4E+3 2E+3 2E+3	1E-6 1E-6 1E-6	5E-9 3E-9 3E-9	2E-5 - -	2E-4 - -
40	Zirconium-93	D, see ⁸⁶ Zr W, see ⁸⁶ Zr Y, see ⁸⁶ Zr	1E+3 Bone surf (3E+3) - -	6E+0 Bone surf (2E+1) 2E+1 Bone surf (6E+1) 6E+1 Bone surf (7E+1)	3E-9 - 1E-8 - 2E-8 -	- 2E-11 - 9E-11 - 9E-11	- 4E-5 - - -	- 4E-4 - - -
40	Zirconium-95	D, see ⁸⁶ Zr W, see ⁸⁶ Zr Y, see ⁸⁶ Zr	1E+3 - - -	1E+2 Bone surf (3E+2) 4E+2 3E+2	5E-8 - 2E-7 1E-7	- 4E-10 5E-10 4E-10	2E-5 - - -	2E-4 - - -

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μ Ci)	Col. 2	Col. 3	Col. 1 Air (μ Ci/ml)	Col. 2 Water (μ Ci/ml)	Monthly Average Concentration (μ Ci/ml)
				ALI (μ Ci)	DAC (μ Ci/ml)			
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-89 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	8E-8	3E-10	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+1	6E-9	2E-11	-	-
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
41	Niobium-95	W, see ^{88}Nb	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		Y, see ^{88}Nb	-	1E+3	5E-7	2E-9	-	-
41	Niobium-96	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-97 ²	W, see ^{88}Nb	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ^{88}Nb	-	7E+4	3E-5	1E-7	-	-
41	Niobium-98 ²	W, see ^{88}Nb	1E+4	5E+4	2E-5	8E-8	2E-4	2E-3
		Y, see ^{88}Nb	-	5E+4	2E-5	7E-8	-	-
42	Molybdenum-90	D, all compounds except those given for Y	4E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, oxides, hydroxides, and MoS ₂	2E+3	5E+3	2E-6	6E-9	-	-
42	Molybdenum-93m	D, see ^{90}Mo	9E+3	2E+4	7E-6	2E-8	6E-5	6E-4
		Y, see ^{90}Mo	4E+3	1E+4	6E-6	2E-8	-	-
42	Molybdenum-93	D, see ^{90}Mo	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		Y, see ^{90}Mo	2E+4	2E+2	8E-8	2E-10	-	-
42	Molybdenum-99	D, see ^{90}Mo	2E+3 LLI wall (1E+3)	3E+3	1E-6	4E-9	-	-
		Y, see ^{90}Mo	1E+3	1E+3	6E-7	2E-9	2E-5	2E-4
42	Molybdenum-101 ²	D, see ^{90}Mo	4E+4 St wall (5E+4)	1E+5	6E-5	2E-7	-	-
							7E-4	7E-3

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III 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)			
		Y, see ⁹⁰ Mo	-	1E+5	6E-5	2E-7	-	-
43	Technetium-93m ²	D, all compounds except those given for W W, oxides, hydroxides, halides, and nitrates	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
			-	3E+5	1E-4	4E-7	-	-
43	Technetium-93	D, see ^{93m} Tc W, see ^{93m} Tc	3E+4	7E+4 1E+5	3E-5 4E-5	1E-7 1E-7	4E-4	4E-3
43	Technetium-94m ²	D, see ^{93m} Tc W, see ^{93m} Tc	2E+4	4E+4 6E+4	2E-5 2E-5	6E-8 8E-8	3E-4	3E-3
43	Technetium-94	D, see ^{93m} Tc W, see ^{93m} Tc	9E+3	2E+4 2E+4	8E-6 1E-5	3E-8 3E-8	1E-4	1E-3
43	Technetium-95m	D, see ^{93m} Tc W, see ^{93m} Tc	4E+3	5E+3 2E+3	2E-6 8E-7	8E-9 3E-9	5E-5	5E-4
43	Technetium-95	D, see ^{93m} Tc W, see ^{93m} Tc	1E+4	2E+4 2E+4	9E-6 8E-6	3E-8 3E-8	1E-4	1E-3
43	Technetium-96m ²	D, see ^{93m} Tc W, see ^{93m} Tc	2E+5	3E+5 2E+5	1E-4 1E-4	4E-7 3E-7	2E-3	2E-2
43	Technetium-96	D, see ^{93m} Tc W, see ^{93m} Tc	2E+3	3E+3 2E+3	1E-6 9E-7	5E-9 3E-9	3E-5	3E-4
43	Technetium-97m	D, see ^{93m} Tc	5E+3	7E+3 St wall (7E+3)	3E-6	-	6E-5	6E-4
		W, see ^{93m} Tc	-	1E+3	5E-7	1E-8 2E-9	-	-
43	Technetium-97	D, see ^{93m} Tc W, see ^{93m} Tc	4E+4	5E+4 6E+3	2E-5 2E-6	7E-8 8E-9	5E-4	5E-3
43	Technetium-98	D, see ^{93m} Tc W, see ^{93m} Tc	1E+3	2E+3 3E+2	7E-7 1E-7	2E-9 4E-10	1E-5	1E-4
43	Technetium-99m	D, see ^{93m} Tc W, see ^{93m} Tc	8E+4	2E+5 2E+5	6E-5 1E-4	2E-7 3E-7	1E-3	1E-2
43	Technetium-99	D, see ^{93m} Tc	4E+3	5E+3 St wall (6E+3)	2E-6	-	6E-5	6E-4
		W, see ^{93m} Tc	-	7E+2	3E-7	8E-9 9E-10	-	-
43	Technetium-101 ²	D, see ^{93m} Tc	9E+4 St wall (1E+5)	3E+5	1E-4	5E-7	-	-
		W, see ^{93m} Tc	-	4E+5	2E-4	5E-7	2E-3	2E-2
43	Technetium-104 ²	D, see ^{93m} Tc	2E+4 St wall (3E+4)	7E+4	3E-5	1E-7	-	-
		W, see ^{93m} Tc	-	9E+4	4E-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

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μ Ci)	Col. 2 Inhalation ALI (μ Ci)	Col. 3 DAC (μ Ci/ml)	Col. 1 Air (μ Ci/ml)	Col. 2 Water (μ Ci/ml)	Monthly Average Concentration (μ Ci/ml)
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 LLI wall (2E+2) - -	9E+1 - 5E+1 1E+1	4E-8 - 2E-8 5E-9	1E-10 - 8E-11 2E-11	- - 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 ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} 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 - -
45	Rhodium-100	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	2E+3 - -	5E+3 4E+3 4E+3	2E-6 2E-6 2E-6	7E-9 6E-9 5E-9	2E-5 - -	2E-4 - -
45	Rhodium-101m	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	6E+3 - -	1E+4 8E+3 8E+3	5E-6 4E-6 3E-6	2E-8 1E-8 1E-8	8E-5 - -	8E-4 - -
45	Rhodium-101	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	2E+3 - -	5E+2 8E+2 2E+2	2E-7 3E-7 6E-8	7E-10 1E-9 2E-10	3E-5 - -	3E-4 - -
45	Rhodium-102m	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	1E+3 LLI wall (1E+3) - -	5E+2 - 4E+2 1E+2	2E-7 - 2E-7 5E-8	7E-10 - 5E-10 2E-10	- - 2E-5 -	- - 2E-4 -
45	Rhodium-102	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	6E+2 - -	9E+1 2E+2 6E+1	4E-8 7E-8 2E-8	1E-10 2E-10 8E-11	8E-6 - -	8E-5 - -
45	Rhodium-103m ²	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	4E+5 - -	1E+6 1E+6 1E+6	5E-4 5E-4 5E-4	2E-6 2E-6 2E-6	6E-3 - -	6E-2 - -
45	Rhodium-105	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	4E+3 LLI wall (4E+3) - -	1E+4 - 6E+3 6E+3	5E-6 - 3E-6 2E-6	2E-8 - 9E-9 8E-9	- - 5E-5 -	- - 5E-4 -
45	Rhodium-106m	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	8E+3 - -	3E+4 4E+4 4E+4	1E-5 2E-5 1E-5	4E-8 5E-8 5E-8	1E-4 - -	1E-3 - -
45	Rhodium-107 ²	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	7E+4 St wall (9E+4) - -	2E+5 - 3E+5 3E+5	1E-4 - 1E-4 1E-4	3E-7 - 4E-7 3E-7	- - 1E-3 -	- - 1E-2 -

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Atomic Radionuclide No.	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers	
		Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)	
			Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)				
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-8	2E-4	2E-3
			-	3E+4	1E-5	5E-8	-	-
			-	3E+4	1E-5	4E-8	-	-
46	Palladium-103	D, see ¹⁰⁰ Pd W, see ¹⁰⁰ Pd Y, see ¹⁰⁰ Pd	6E+3	6E+3	3E-6	9E-9	-	-
			LLI wall (7E+3)	-	-	-	1E-4	1E-3
			-	4E+3	2E-6	6E-9	-	-
46	Palladium-107	D, see ¹⁰⁰ Pd W, see ¹⁰⁰ Pd Y, see ¹⁰⁰ Pd	3E+4	2E+4	9E-6	-	-	-
			LLI wall (4E+4)	Kidneys (2E+4)	-	3E-8	5E-4	5E-3
			-	7E+3	3E-6	1E-8	-	-
46	Palladium-109	D, see ¹⁰⁰ Pd W, see ¹⁰⁰ Pd Y, see ¹⁰⁰ Pd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
			-	5E+3	2E-6	8E-9	-	-
			-	5E+3	2E-6	6E-9	-	-
47	Silver-102 ²	D, all compounds except those given for W and Y W, nitrates and sulfides Y, oxides and hydroxides	5E+4	2E+5	8E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	9E-4	9E-3
			-	2E+5	9E-5	3E-7	-	-
47	Silver-103 ²	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
			-	1E+5	5E-5	2E-7	-	-
			-	1E+5	5E-5	2E-7	-	-
47	Silver-104m ²	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	3E+4	9E+4	4E-5	1E-7	4E-4	4E-3
			-	1E+5	5E-5	2E-7	-	-
			-	1E+5	5E-5	2E-7	-	-
47	Silver-104 ²	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
			-	1E+5	6E-5	2E-7	-	-
			-	1E+5	6E-5	2E-7	-	-
47	Silver-105	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	3E+3	1E+3	4E-7	1E-9	4E-5	4E-4
			-	2E+3	7E-7	2E-9	-	-
			-	2E+3	7E-7	2E-9	-	-
47	Silver-106m	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	8E+2	7E+2	3E-7	1E-9	1E-5	1E-4
			-	9E+2	4E-7	1E-9	-	-
			-	9E+2	4E-7	1E-9	-	-
47	Silver-106 ²	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	6E+4	2E+5	8E-5	3E-7	-	-
			St. wall (6E+4)	-	-	-	9E-4	9E-3
			-	2E+5	9E-5	3E-7	-	-
47	Silver-108m	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	6E+2	2E+2	8E-8	3E-10	9E-6	9E-5
			-	3E+2	1E-7	4E-10	-	-
			-	2E+1	1E-8	3E-11	-	-
47	Silver-110m	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	5E+2	1E+2	5E-8	2E-10	6E-6	6E-5
			-	2E+2	8E-8	3E-10	-	-
			-	9E+1	4E-8	1E-10	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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 ($\mu\text{Ci}/\text{ml}$)			
47	Silver-111	D, see ^{102}Ag	9E+2 LLI wall (1E+3)	2E+3 Liver (2E+3)	6E-7	-	-	-
		W, see ^{102}Ag	-	9E+2	4E-7	2E-9	2E-5	2E-4
		Y, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-112	D, see ^{102}Ag	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{102}Ag	-	1E+4	4E-6	1E-8	-	-
		Y, see ^{102}Ag	-	9E+3	4E-6	1E-8	-	-
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	-	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 W, sulfides, halides, and nitrates Y, oxides and hydroxides	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
			-	1E+5	5E-5	2E-7	-	-
			-	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-8	-	-	-
		W, see ^{104}Cd	-	1E+2 Kidneys (1E+2)	5E-8	7E-11	6E-6	6E-5
		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)	1E-9	-	-	-
		W, see ^{104}Cd	-	8E+0 Kidneys (1E+1)	4E-9	5E-12	5E-7	5E-6
		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)	9E-10	-	-	-
		W, see ^{104}Cd	-	8E+0 Kidneys (1E+1)	3E-9	5E-12	4E-7	4E-6
		Y, see ^{104}Cd	-	1E+1	6E-9	2E-11	-	-
48	Cadmium-115m	D, see ^{104}Cd	3E+2	5E+1 Kidneys (8E+1)	2E-8	-	4E-6	4E-5
		W, see ^{104}Cd	-	1E+2	5E-8	1E-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	-	1E-5	1E-4
		Y, see ^{104}Cd	-	1E+3	6E-7	2E-9	-	-
48	Cadmium-117m	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 I Occupational Values			Table II Effluent Concentrations		Table III Release 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 ($\mu\text{Ci}/\text{ml}$)			
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-113m 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-114m	D, see ^{109}In W, see ^{109}In	3E+2 LLI wall (4E+2) -	6E+1 - 1E+2	3E-8 - 4E-8	9E-11 - 1E-10	- 5E-6 -	- 5E-5 -
49	Indium-115m	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-116m 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-117m 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-119m ²	D, see ^{109}In W, see ^{109}In	4E+4 St wall (5E+4) -	1E+5 - 1E+5	5E-5 - 6E-5	2E-7 - 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 -
50	Tin-113	D, see ^{110}Sn W, see ^{110}Sn	2E+3 LLI wall (2E+3) -	1E+3 - 5E+2	5E-7 - 2E-7	2E-9 - 8E-10	- 3E-5 -	- 3E-4 -

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
50	Tin-117m	D, see ¹¹⁰ Sn	2E+3 LLI wall (2E+3)	1E+3 Bone surf (2E+3)	5E-7	-	-	-
		W, see ¹¹⁰ Sn	-	1E+3	6E-7	3E-9 2E-9	3E-5	3E-4
50	Tin-119m	D, see ¹¹⁰ Sn	3E+3 LLI wall (4E+3)	2E+3	1E-6	3E-9	-	-
		W, see ¹¹⁰ Sn	-	1E+3	4E-7	1E-9	6E-5	6E-4
50	Tin-121m	D, see ¹¹⁰ Sn	3E+3 LLI wall (4E+3)	9E+2	4E-7	1E-9	-	-
		W, see ¹¹⁰ Sn	-	5E+2	2E-7	8E-10	5E-5	5E-4
50	Tin-121	D, see ¹¹⁰ Sn	6E+3 LLI wall (6E+3)	2E+4	6E-6	2E-8	-	-
		W, see ¹¹⁰ Sn	-	1E+4	5E-6	2E-8	8E-5	8E-4
50	Tin-123m ²	D, see ¹¹⁰ Sn	5E+4	1E+5	5E-5	2E-7	7E-4	7E-3
		W, see ¹¹⁰ Sn	-	1E+5	6E-5	2E-7	-	-
50	Tin-123	D, see ¹¹⁰ Sn	5E+2 LLI wall (6E+2)	6E+2	3E-7	9E-10	-	-
		W, see ¹¹⁰ Sn	-	2E+2	7E-8	2E-10	9E-6	9E-5
50	Tin-125	D, see ¹¹⁰ Sn	4E+2 LLI wall (5E+2)	9E+2	4E-7	1E-9	-	-
		W, see ¹¹⁰ Sn	-	4E+2	1E-7	5E-10	6E-6	6E-5
50	Tin-126	D, see ¹¹⁰ Sn	3E+2	6E+1	2E-8	8E-11	4E-6	4E-5
		W, see ¹¹⁰ Sn	-	7E+1	3E-8	9E-11	-	-
50	Tin-127	D, see ¹¹⁰ Sn	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		W, see ¹¹⁰ Sn	-	2E+4	8E-6	3E-8	-	-
50	Tin-128 ²	D, see ¹¹⁰ Sn	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, see ¹¹⁰ Sn	-	4E+4	1E-5	5E-8	-	-
51	Antimony-115 ²	D, all compounds except those given for W	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, sulfides, sulfates, and nitrates	-	3E+5	1E-4	4E-7	-	-
51	Antimony-116m ²	D, see ¹¹⁵ Sb	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ¹¹⁵ Sb	-	1E+5	6E-5	2E-7	-	-
51	Antimony-116 ²	D, see ¹¹⁵ Sb	7E+4 St wall (9E+4)	3E+5	1E-4	4E-7	-	-
		W, see ¹¹⁵ Sb	-	3E+5	1E-4	5E-7	1E-3	1E-2
51	Antimony-117	D, see ¹¹⁵ Sb	7E+4	2E+5	9E-5	3E-7	9E-4	9E-3
		W, see ¹¹⁵ Sb	-	3E+5	1E-4	4E-7	-	-
51	Antimony-118m	D, see ¹¹⁵ Sb	6E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		W, see ¹¹⁵ Sb	5E+3	2E+4	9E-6	3E-8	-	-
51	Antimony-119	D, see ¹¹⁵ Sb	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		W, see ¹¹⁵ Sb	2E+4	3E+4	1E-5	4E-8	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μ Ci)	Col. 2 ALI (μ Ci)	Col. 3 DAC (μ Ci/ml)	Col. 1 Air (μ Ci/ml)	Col. 2 Water (μ Ci/ml)	Monthly Average Concentration (μ Ci/ml)
51	Antimony-120 ² (16 min)	D, see ¹¹⁵ Sb	1E+5 St wall (2E+5)	4E+5	2E-4	6E-7	-	-
		W, see ¹¹⁵ Sb	-	5E+5	2E-4	7E-7	2E-3	2E-2
51	Antimony-120 (5.76 d)	D, see ¹¹⁵ Sb	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		W, see ¹¹⁵ Sb	9E+2	1E+3	5E-7	2E-9	-	-
51	Antimony-122	D, see ¹¹⁵ Sb	8E+2 LLI wall (8E+2)	2E+3	1E-6	3E-9	-	-
		W, see ¹¹⁵ Sb	7E+2	1E+3	4E-7	2E-9	1E-5	1E-4
51	Antimony-124m ²	D, see ¹¹⁵ Sb	3E+5	8E+5	4E-4	1E-6	3E-3	3E-2
		W, see ¹¹⁵ Sb	2E+5	6E+5	2E-4	8E-7	-	-
51	Antimony-124	D, see ¹¹⁵ Sb	6E+2	9E+2	4E-7	1E-9	7E-6	7E-5
		W, see ¹¹⁵ Sb	5E+2	2E+2	1E-7	3E-10	-	-
51	Antimony-125	D, see ¹¹⁵ Sb	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
		W, see ¹¹⁵ Sb	-	5E+2	2E-7	7E-10	-	-
51	Antimony-126m ²	D, see ¹¹⁵ Sb	5E+4 St wall (7E+4)	2E+5	8E-5	3E-7	-	-
		W, see ¹¹⁵ Sb	-	2E+5	8E-5	3E-7	9E-4	9E-3
51	Antimony-126	D, see ¹¹⁵ Sb	6E+2	1E+3	5E-7	2E-9	7E-6	7E-5
		W, see ¹¹⁵ Sb	5E+2	5E+2	2E-7	7E-10	-	-
51	Antimony-127	D, see ¹¹⁵ Sb	8E+2 LLI wall (8E+2)	2E+3	9E-7	3E-9	-	-
		W, see ¹¹⁵ Sb	7E+2	9E+2	4E-7	1E-9	1E-5	1E-4
51	Antimony-128 ² (10.4 min)	D, see ¹¹⁵ Sb	8E+4 St wall (1E+5)	4E+5	2E-4	5E-7	-	-
		W, see ¹¹⁵ Sb	-	4E+5	2E-4	6E-7	1E-3	1E-2
51	Antimony-128 (9.01 h)	D, see ¹¹⁵ Sb	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, see ¹¹⁵ Sb	-	3E+3	1E-6	5E-9	-	-
51	Antimony-129	D, see ¹¹⁵ Sb	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, see ¹¹⁵ Sb	-	9E+3	4E-6	1E-8	-	-
51	Antimony-130 ²	D, see ¹¹⁵ Sb	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, see ¹¹⁵ Sb	-	8E+4	3E-5	1E-7	-	-
51	Antimony-131 ²	D, see ¹¹⁵ Sb	1E+4 Thyroid (2E+4)	2E+4 Thyroid (4E+4)	1E-5	-	-	-
		W, see ¹¹⁵ Sb	-	2E+4 Thyroid (4E+4)	1E-5	6E-8	2E-4	2E-3
		-	-	-	6E-8	-	-	
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 ¹¹⁰ Te	5E+2 Bone surf (7E+2)	2E+2 Bone surf (4E+2)	8E-8	-	-	-
		W, see ¹¹⁰ Te	-	4E+2	2E-7	5E-10 6E-10	1E-5	1E-4

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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 ($\mu\text{Ci}/\text{ml}$)
			ALI (μCi)	DAC ($\mu\text{Ci}/\text{ml}$)				
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	2E+2	9E-8	-	-	-
		W, see ^{116}Te	Bone surf (1E+3)	Bone surf (5E+2)	-	8E-10	1E-5	1E-4
52	Tellurium-123	D, see ^{116}Te	-	5E+2	2E-7	8E-10	-	-
		W, see ^{116}Te	5E+2	2E+2	8E-8	-	-	-
52	Tellurium-125m	D, see ^{116}Te	Bone surf (1E+3)	Bone surf (5E+2)	-	7E-10	2E-5	2E-4
		W, see ^{116}Te	-	4E+2	2E-7	-	-	-
52	Tellurium-127m	D, see ^{116}Te	Bone surf (1E+3)	Bone surf (1E+3)	-	2E-9	-	-
		W, see ^{116}Te	-	7E+2	3E-7	1E-9	2E-5	2E-4
52	Tellurium-127	D, see ^{116}Te	6E+2	3E+2	1E-7	-	9E-6	9E-5
		W, see ^{116}Te	-	Bone surf (4E+2)	-	6E-10	-	-
52	Tellurium-129m	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-129 ²	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-131m	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-131 ²	D, see ^{116}Te	3E+2	4E+2	2E-7	-	-	-
		W, see ^{116}Te	Thyroid (6E+2)	Thyroid (1E+3)	-	2E-9	8E-6	8E-5
52	Tellurium-132	D, see ^{116}Te	-	4E+2	2E-7	-	-	-
		W, see ^{116}Te	-	Thyroid (9E+2)	-	1E-9	-	-
52	Tellurium-133m ²	D, see ^{116}Te	3E+3	5E+3	2E-6	-	-	-
		W, see ^{116}Te	Thyroid (6E+3)	Thyroid (1E+4)	-	2E-8	8E-5	8E-4
52	Tellurium-133 ²	D, see ^{116}Te	-	5E+3	2E-6	-	-	-
		W, see ^{116}Te	-	Thyroid (1E+4)	-	2E-8	-	-
52	Tellurium-133 ²	D, see ^{116}Te	2E+2	2E+2	9E-8	-	-	-
		W, see ^{116}Te	Thyroid (7E+2)	Thyroid (8E+2)	-	1E-9	9E-6	9E-5
52	Tellurium-133m ²	D, see ^{116}Te	-	2E+2	9E-8	-	-	-
		W, see ^{116}Te	-	Thyroid (6E+2)	-	9E-10	-	-
52	Tellurium-133m ²	D, see ^{116}Te	3E+3	5E+3	2E-6	-	-	-
		W, see ^{116}Te	Thyroid (6E+3)	Thyroid (1E+4)	-	2E-8	9E-5	9E-4
52	Tellurium-133 ²	D, see ^{116}Te	-	5E+3	2E-6	-	-	-
		W, see ^{116}Te	-	Thyroid (1E+4)	-	2E-8	-	-
52	Tellurium-133 ²	D, see ^{116}Te	1E+4	2E+4	9E-6	-	-	-
		W, see ^{116}Te	Thyroid (3E+4)	Thyroid (6E+4)	-	8E-8	4E-4	4E-3
			-	2E+4	9E-6	-	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)			
				Thyroid (6E+4)		8E-8		
52	Tellurium-134 ²	D, see ¹¹⁸ Te	2E+4 Thyroid (2E+4)	2E+4 Thyroid (5E+4)	1E-5	-	-	-
		W, see ¹¹⁸ Te	-	2E+4 Thyroid (5E+4)	1E-5	7E-8	3E-4	3E-3
			-			7E-8	-	-
53	Iodine-120m ²	D, all compounds	1E+4 Thyroid (1E+4)	2E+4	9E-6	3E-8	-	-
							2E-4	2E-3
53	Iodine-120 ²	D, all compounds	4E+3 Thyroid (8E+3)	9E+3 Thyroid (1E+4)	4E-6	-	-	-
						2E-8	1E-4	1E-3
53	Iodine-121	D, all compounds	1E+4 Thyroid (3E+4)	2E+4 Thyroid (5E+4)	8E-6	-	-	-
						7E-8	4E-4	4E-3
53	Iodine-123	D, all compounds	3E+3 Thyroid (1E+4)	6E+3 Thyroid (2E+4)	3E-6	-	-	-
						2E-8	1E-4	1E-3
53	Iodine-124	D, all compounds	5E+1 Thyroid (2E+2)	8E+1 Thyroid (3E+2)	3E-8	-	-	-
						4E-10	2E-6	2E-5
53	Iodine-125	D, all compounds	4E+1 Thyroid (1E+2)	6E+1 Thyroid (2E+2)	3E-8	-	-	-
						3E-10	2E-6	2E-5
53	Iodine-126	D, all compounds	2E+1 Thyroid (7E+1)	4E+1 Thyroid (1E+2)	1E-8	-	-	-
						2E-10	1E-6	1E-5
53	Iodine-128 ²	D, all compounds	4E+4 St wall (6E+4)	1E+5	5E-5	2E-7	-	-
							8E-4	8E-3
53	Iodine-129	D, all compounds	5E+0 Thyroid (2E+1)	9E+0 Thyroid (3E+1)	4E-9	-	-	-
						4E-11	2E-7	2E-6
53	Iodine-130	D, all compounds	4E+2 Thyroid (1E+3)	7E+2 Thyroid (2E+3)	3E-7	-	-	-
						3E-9	2E-5	2E-4
53	Iodine-131	D, all compounds	3E+1 Thyroid (9E+1)	5E+1 Thyroid (2E+2)	2E-8	-	-	-
						2E-10	1E-6	1E-5
53	Iodine-132m ²	D, all compounds	4E+3 Thyroid (1E+4)	8E+3 Thyroid (2E+4)	4E-6	-	-	-
						3E-8	1E-4	1E-3
53	Iodine-132	D, all compounds	4E+3 Thyroid (9E+3)	8E+3 Thyroid (1E+4)	3E-6	-	-	-
						2E-8	1E-4	1E-3

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
53	Iodine-133	D, all compounds	1E+2 Thyroid (5E+2)	3E+2 Thyroid (9E+2)	1E-7 -	- 1E-9	- 7E-6	- 7E-5
53	Iodine-134 ²	D, all compounds	2E+4 Thyroid (3E+4)	5E+4 -	2E-5 -	6E-8 -	- 4E-4	- 4E-3
53	Iodine-135	D, all compounds	8E+2 Thyroid (3E+3)	2E+3 Thyroid (4E+3)	7E-7 -	- 6E-9	- 3E-5	- 3E-4
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-125	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 -	- 1E-3	- 1E-2
55	Cesium-127	D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3
55	Cesium-129	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
55	Cesium-130 ²	D, all compounds	6E+4 St wall (1E+5)	2E+5 -	8E-5 -	3E-7 -	- 1E-3	- 1E-2
55	Cesium-131	D, all compounds	2E+4	3E+4	1E-5	4E-8	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 St wall (1E+5)	1E+5 -	6E-5 -	2E-7 -	- 2E-3	- 2E-2
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	5E-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

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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 ($\mu\text{Ci}/\text{ml}$)			
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 St wall (3E+4)	6E+4	2E-5	8E-8	- 4E-4	- 4E-3
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 St wall (5E+5)	1E+6	6E-4	2E-6	- 7E-3	- 7E-2
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	- 4E-5	- 4E-4
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-139 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	- 8E-6	- 8E-5
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 W, oxides and hydroxides	5E+4 -	1E+5 2E+5	5E-5 7E-5	2E-7 2E-7	6E-4 -	6E-3 -
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)	- - 1E-7 -	1E-10 - - 4E-10	- - - -	- - - -
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 ²	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	4E+4 St wall	1E+5	4E-5	1E-7	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μ Ci)	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μ Ci/ml)
			ALI (μ Ci)	ALI (μ Ci)	DAC (μ Ci/ml)	Air (μ Ci/ml)	Water (μ Ci/ml)	
		W, see ¹³¹ La	(4E+4)	-	-	-	5E-4	5E-3
58	Cerium-134	W, all compounds except those given for Y	5E+2 LLI wall (6E+2)	9E+4	4E-5	1E-7	-	-
		Y, oxides, hydroxides, and fluorides	-	7E+2	3E-7	9E-10	8E-6	8E-5
58	Cerium-135	W, see ¹³⁴ Ce	2E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		Y, see ¹³⁴ Ce	-	4E+3	1E-6	5E-9	-	-
58	Cerium-137m	W, see ¹³⁴ Ce	2E+3 LLI wall (2E+3)	4E+3	2E-6	6E-9	-	-
		Y, see ¹³⁴ Ce	-	4E+3	2E-6	5E-9	3E-5	3E-4
58	Cerium-137	W, see ¹³⁴ Ce	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		Y, see ¹³⁴ Ce	-	1E+5	5E-5	2E-7	-	-
58	Cerium-139	W, see ¹³⁴ Ce	5E+3	8E+2	3E-7	1E-9	7E-5	7E-4
		Y, see ¹³⁴ Ce	-	7E+2	3E-7	9E-10	-	-
58	Cerium-141	W, see ¹³⁴ Ce	2E+3 LLI wall (2E+3)	7E+2	3E-7	1E-9	-	-
		Y, see ¹³⁴ Ce	-	6E+2	2E-7	8E-10	3E-5	3E-4
	Cerium-143	W, see ¹³⁴ Ce	1E+3 LLI wall (1E+3)	2E+3	8E-7	3E-9	-	-
		Y, see ¹³⁴ Ce	-	2E+3	7E-7	2E-9	2E-5	2E-4
58	Cerium-144	W, see ¹³⁴ Ce	2E+2 LLI wall (3E+2)	3E+1	1E-8	4E-11	-	-
		Y, see ¹³⁴ Ce	-	1E+1	6E-9	2E-11	3E-6	3E-5
59	Praseodymium-136 ² W, all compounds except those given for Y		5E+4 St wall (7E+4)	2E+5	1E-4	3E-7	-	-
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	9E-5	3E-7	1E-3	1E-2
59	Praseodymium-137 ² W, see ¹³⁶ Pr		4E+4	2E+5	6E-5	2E-7	5E-4	5E-3
		Y, see ¹³⁶ Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-138m W, see ¹³⁶ Pr		1E+4	5E+4	2E-5	8E-8	1E-4	1E-3
		Y, see ¹³⁶ Pr	-	4E+4	2E-5	6E-8	-	-
59	Praseodymium-139 W, see ¹³⁶ Pr		4E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ¹³⁶ Pr	-	1E+5	5E-5	2E-7	-	-
59	Praseodymium-142m ² W, see ¹³⁶ Pr		8E+4	2E+5	7E-5	2E-7	1E-3	1E-2
		Y, see ¹³⁶ Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-142 W, see ¹³⁶ Pr		1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		Y, see ¹³⁶ Pr	-	2E+3	8E-7	3E-9	-	-
59	Praseodymium-143 W, see ¹³⁶ Pr		9E+2 LLI wall (1E+3)	8E+2	3E-7	1E-9	-	-
		Y, see ¹³⁶ Pr	-	7E+2	3E-7	9E-10	2E-5	2E-4

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)			
59	Praseodymium-144 ² W, see ¹³⁶ Pr		3E+4 St wall (4E+4)	1E+5	5E-5	2E-7	-	-
	Y, see ¹³⁶ Pr		-	1E+5	5E-5	2E-7	6E-4	6E-3
59	Praseodymium-145 W, see ¹³⁶ Pr		3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
	Y, see ¹³⁶ Pr		-	8E+3	3E-6	1E-8	-	-
59	Praseodymium-147 ² W, see ¹³⁶ Pr		5E+4 St wall (8E+4)	2E+5	8E-5	3E-7	-	-
	Y, see ¹³⁶ Pr		-	2E+5	8E-5	3E-7	1E-3	1E-2
60	Neodymium-136 ²	W, all compounds except those given for Y	1E+4	6E+4	2E-5	8E-8	2E-4	2E-3
		Y, oxides, hydroxides, carbides, and fluorides	-	5E+4	2E-5	8E-8	-	-
60	Neodymium-138	W, see ¹³⁶ Nd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
	Y, see ¹³⁶ Nd		-	5E+3	2E-6	7E-9	-	-
60	Neodymium-139m	W, see ¹³⁶ Nd	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
	Y, see ¹³⁶ Nd		-	1E+4	6E-6	2E-8	-	-
60	Neodymium-139 ²	W, see ¹³⁶ Nd	9E+4	3E+5	1E-4	5E-7	1E-3	1E-2
	Y, see ¹³⁶ Nd		-	3E+5	1E-4	4E-7	-	-
60	Neodymium-141	W, see ¹³⁶ Nd	2E+5	7E+5	3E-4	1E-6	2E-3	2E-2
	Y, see ¹³⁶ Nd		-	6E+5	3E-4	9E-7	-	-
60	Neodymium-147	W, see ¹³⁶ Nd	1E+3 LLI wall (1E+3)	9E+2	4E-7	1E-9	-	-
	Y, see ¹³⁶ Nd		-	8E+2	4E-7	1E-9	2E-5	2E-4
60	Neodymium-149 ²	W, see ¹³⁶ Nd	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
	Y, see ¹³⁶ Nd		-	2E+4	1E-5	3E-8	-	-
60	Neodymium-151 ²	W, see ¹³⁶ Nd	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
	Y, see ¹³⁶ Nd		-	2E+5	8E-5	3E-7	-	-
61	Promethium-141 ²	W, all compounds except those given for Y	5E+4 St wall (6E+4)	2E+5	8E-5	3E-7	-	-
	Y, oxides, hydroxides, carbides, and fluorides		-	2E+5	7E-5	2E-7	8E-4	8E-3
61	Promethium-143	W, see ¹⁴¹ Pm	5E+3	6E+2	2E-7	8E-10	7E-5	7E-4
	Y, see ¹⁴¹ Pm		-	7E+2	3E-7	1E-9	-	-
61	Promethium-144	W, see ¹⁴¹ Pm	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
	Y, see ¹⁴¹ Pm		-	1E+2	5E-8	2E-10	-	-
61	Promethium-145	W, see ¹⁴¹ Pm	1E+4	2E+2	7E-8	-	1E-4	1E-3
	Y, see ¹⁴¹ Pm		-	Bone surf (2E+2)	-	3E-10	-	-
			-	2E+2	8E-8	3E-10	-	-
61	Promethium-146	W, see ¹⁴¹ Pm	2E+3	5E+1	2E-8	7E-11	2E-5	2E-4
	Y, see ¹⁴¹ Pm		-	4E+1	2E-8	6E-11	-	-
61	Promethium-147	W, see ¹⁴¹ Pm	4E+3 LLI wall (5E+3)	1E+2	5E-8	-	-	-
			-	Bone surf (2E+2)	-	3E-10	7E-5	7E-4

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
		Y, see ¹⁴¹ Pm	-	1E+2	6E-8	2E-10	-	-
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	4E+2 LLI wall (5E+2)	5E+2	2E-7	8E-10	-	-
		Y, see ¹⁴¹ Pm	-	5E+2	2E-7	7E-10	-	7E-5
61	Promethium-149	W, see ¹⁴¹ Pm	1E+3 LLI wall (1E+3)	2E+3	8E-7	3E-9	-	-
		Y, see ¹⁴¹ Pm	-	2E+3	8E-7	2E-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 -
62	Samarium-141m 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	-	-
			-	-	-	-	8E-4	8E-3
62	Samarium-142 ²	W, all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
	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 -	- 9E-14	- 3E-7	- 3E-6
62	Samarium-147	W, all compounds	2E+1 Bone surf (3E+1)	4E-2 Bone surf (7E-2)	2E-11 -	- 1E-13	- 4E-7	- 4E-6
62	Samarium-151	W, all compounds	1E+4 LLI wall (1E+4)	1E+2 Bone surf (2E+2)	4E-8 -	- 2E-10	- 2E-4	- 2E-3
62	Samarium-153	W, all compounds	2E+3 LLI wall (2E+3)	3E+3	1E-6 -	4E-9 -	- 3E-5	- 3E-4
62	Samarium-155 ²	W, all compounds	6E+4 St wall (8E+4)	2E+5	9E-5 -	3E-7 -	- 1E-3	- 1E-2
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

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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 ($\mu\text{Ci}/\text{ml}$)			
63	Europium-150 (34.2 y)	W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
63	Europium-152m	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	- 2E-10	5E-5	5E-4
63	Europium-156	W, all compounds	6E+2	5E+2	2E-7	6E-10	8E-6	8E-5
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)	2E+5	6E-5	2E-7	- 6E-4	- 6E-3
		W, oxides, hydroxides, and fluorides	-	2E+5	7E-5	2E-7	-	-
64	Gadolinium-146	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	1E+3 -	1E+2 3E+2	5E-8 1E-7	2E-10 4E-10	2E-5 -	2E-4 -
64	Gadolinium-147	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	2E+3 -	4E+3 4E+3	2E-6 1E-6	6E-9 5E-9	3E-5 -	3E-4 -
64	Gadolinium-148	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	1E+1 Bone surf (2E+1) - -	8E+3 Bone surf (2E-2) 3E-2 Bone surf (6E-2) -	3E-12 - 1E-11 -	- 2E-14 - 8E-14	- 3E-7 -	- 3E-6 -
64	Gadolinium-149	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	3E+3 -	2E+3 2E+3	9E-7 1E-6	3E-9 3E-9	4E-5 -	4E-4 -
64	Gadolinium-151	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	6E+3 -	4E+2 Bone surf (6E+2) 1E+3	2E-7 - 5E-7	- 9E-10 2E-9	9E-5 -	9E-4 -
64	Gadolinium-152	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	2E+1 Bone surf (3E+1) - -	1E-2 Bone surf (2E-2) 4E-2 Bone surf (8E-2) -	4E-12 - 2E-11 -	- 3E-14 - 1E-13	- 4E-7 -	- 4E-6 -
64	Gadolinium-153	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	5E+3 -	1E+2 Bone surf (2E+2) 6E+2	6E-8 - 2E-7	- 3E-10 8E-10	6E-5 -	6E-4 -
64	Gadolinium-159	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	3E+3 -	8E+3 6E+3	3E-6 2E-6	1E-8 8E-9	4E-5 -	4E-4 -
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

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
65	Terbium-150	W, all compounds	5E+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
65	Terbium-156m (24.4 h)	W, all compounds	7E+3	8E+3	3E-6	1E-8	1E-4	1E-3
65	Terbium-156	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
65	Terbium-157	W, all compounds	5E+4 LLI wall (5E+4)	3E+2 Bone surf (6E+2)	1E-7	- 8E-10	- 7E-4	- 7E-3
65	Terbium-158	W, all compounds	1E+3	2E+1	8E-9	3E-11	2E-5	2E-4
65	Terbium-160	W, all compounds	8E+2	2E+2	9E-8	3E-10	1E-5	1E-4
65	Terbium-161	W, all compounds	2E+3 LLI wall (2E+3)	2E+3	7E-7	2E-9	- 3E-5	- 3E-4
66	Dysprosium-155	W, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
66	Dysprosium-157	W, all compounds	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
66	Dysprosium-159	W, all compounds	1E+4	2E+3	1E-6	3E-9	2E-4	2E-3
66	Dysprosium-165	W, all compounds	1E+4	5E+4	2E-5	6E-8	2E-4	2E-3
66	Dysprosium-166	W, all compounds	6E+2 LLI wall (8E+2)	7E+2	3E-7	1E-9	- 1E-5	- 1E-4
67	Holmium-155 ²	W, all compounds	4E+4	2E+5	6E-5	2E-7	6E-4	6E-3
67	Holmium-157 ²	W, all compounds	3E+5	1E+6	6E-4	2E-6	4E-3	4E-2
67	Holmium-159 ²	W, all compounds	2E+5	1E+6	4E-4	1E-6	3E-3	3E-2
67	Holmium-161	W, all compounds	1E+5	4E+5	2E-4	6E-7	1E-3	1E-2
67	Holmium-162m ²	W, all compounds	5E+4	3E+5	1E-4	4E-7	7E-4	7E-3
67	Holmium-162 ²	W, all compounds	5E+5 St wall (8E+5)	2E+6	1E-3	3E-6	- 1E-2	- 1E-1
67	Holmium-164m ²	W, all compounds	1E+5	3E+5	1E-4	4E-7	1E-3	1E-2
67	Holmium-164 ²	W, all compounds	2E+5 St wall (2E+5)	6E+5	3E-4	9E-7	- 3E-3	- 3E-2
67	Holmium-166m	W, all compounds	6E+2	7E+0	3E-9	9E-12	9E-6	9E-5
67	Holmium-166	W, all compounds	9E+2	2E+3	7E-7	2E-9	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III 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)			
			LLI wall (9E+2)	-	-	-	1E-5	1E-4
67	Holmium-167	W, all compounds	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
68	Erbium-161	W, all compounds	2E+4	6E+4	3E-5	9E-8	2E-4	2E-3
68	Erbium-165	W, all compounds	6E+4	2E+5	8E-5	3E-7	9E-4	9E-3
68	Erbium-169	W, all compounds	3E+3 LLI wall (4E+3)	3E+3	1E-6	4E-9	- 5E-5	- 5E-4
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	- 2E-5	- 2E-4
69	Thulium-162 ²	W, all compounds	7E+4 St wall (7E+4)	3E+5	1E-4	4E-7	- 1E-3	- 1E-2
69	Thulium-166	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	- 3E-5	- 3E-4
69	Thulium-170	W, all compounds	8E+2 LLI wall (1E+3)	2E+2	9E-8	3E-10	- 1E-5	- 1E-4
69	Thulium-171	W, all compounds	1E+4 LLI wall (1E+4)	3E+2 Bone surf (6E+2)	1E-7	- 8E-10	- 2E-4	- 2E-3
69	Thulium-172	W, all compounds	7E+2 LLI wall (8E+2)	1E+3	5E-7	2E-9	- 1E-5	- 1E-4
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	- 1E-3	- 1E-2
70	Ytterbium-162 ²	W, all compounds except those given for Y Y, oxides, hydroxides, and fluorides	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
			-	3E+5	1E-4	4E-7	-	-
70	Ytterbium-166	W, see ¹⁶² Yb Y, see ¹⁶² Yb	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
			-	2E+3	8E-7	3E-9	-	-
70	Ytterbium-167 ²	W, see ¹⁶² Yb Y, see ¹⁶² Yb	3E+5	8E+5	3E-4	1E-6	4E-3	4E-2
			-	7E+5	3E-4	1E-6	-	-
70	Ytterbium-169	W, see ¹⁶² Yb Y, see ¹⁶² Yb	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
			-	7E+2	3E-7	1E-9	-	-
70	Ytterbium-175	W, see ¹⁶² Yb	3E+3 LLI wall (3E+3)	4E+3	1E-6	5E-9	-	-
		Y, see ¹⁶² Yb	-	3E+3	1E-6	5E-9	4E-5	4E-4

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μCi)	Col. 2	Col. 3	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Inhalation				
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)			
70	Ytterbium-177 ²	W, see ¹⁶² Yb	2E+4	5E+4	2E-5	7E-8	2E-4	2E-3
		Y, see ¹⁶² Yb	-	5E+4	2E-5	6E-8	-	-
70	Ytterbium-178 ²	W, see ¹⁶² Yb	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		Y, see ¹⁶² Yb	-	4E+4	2E-5	5E-8	-	-
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	1E+3	2E+3	9E-7	3E-9	2E-5	2E-4
		Y, see ¹⁶⁹ Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-171	W, see ¹⁶⁹ Lu	2E+3	2E+3	8E-7	3E-9	3E-5	3E-4
		Y, see ¹⁶⁹ Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-172	W, see ¹⁶⁹ Lu	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
		Y, see ¹⁶⁹ Lu	-	1E+3	5E-7	2E-9	-	-
71	Lutetium-173	W, see ¹⁶⁹ Lu	5E+3	3E+2	1E-7	-	7E-5	7E-4
		Y, see ¹⁶⁹ Lu	-	Bone surf (5E+2)	-	6E-10	-	-
71	Lutetium-174m	W, see ¹⁶⁹ Lu	2E+3	2E+2	1E-7	-	-	-
		Y, see ¹⁶⁹ Lu	-	Bone surf (3E+3)	-	5E-10	4E-5	4E-4
71	Lutetium-174	W, see ¹⁶⁹ Lu	5E+3	1E+2	5E-8	-	7E-5	7E-4
		Y, see ¹⁶⁹ Lu	-	Bone surf (2E+2)	-	3E-10	-	-
71	Lutetium-176m	W, see ¹⁶⁹ Lu	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		Y, see ¹⁶⁹ Lu	-	2E+4	9E-6	3E-8	-	-
71	Lutetium-176	W, see ¹⁶⁹ Lu	7E+2	5E+0	2E-9	-	1E-5	1E-4
		Y, see ¹⁶⁹ Lu	-	Bone surf (1E+1)	-	2E-11	-	-
71	Lutetium-177m	W, see ¹⁶⁹ Lu	7E+2	1E+2	5E-8	-	1E-5	1E-4
		Y, see ¹⁶⁹ Lu	-	Bone surf (1E+2)	-	2E-10	-	-
71	Lutetium-177	W, see ¹⁶⁹ Lu	2E+3	2E+3	9E-7	3E-9	-	-
		Y, see ¹⁶⁹ Lu	-	LLI wall (3E+3)	-	-	4E-5	4E-4
71	Lutetium-178m ²	W, see ¹⁶⁹ Lu	5E+4	2E+5	8E-5	3E-7	-	-
		Y, see ¹⁶⁹ Lu	-	St. wall (6E+4)	-	-	8E-4	8E-3
71	Lutetium-178 ²	W, see ¹⁶⁹ Lu	4E+4	1E+5	5E-5	2E-7	-	-
		Y, see ¹⁶⁹ Lu	-	St. wall (4E+4)	-	-	6E-4	6E-3
71	Lutetium-179	W, see ¹⁶⁹ Lu	6E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ¹⁶⁹ Lu	-	2E+4	6E-6	3E-8	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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 ($\mu\text{Ci}/\text{ml}$)			
72	Hafnium-170	D, all compounds except those given for W W, oxides, hydroxides, carbides, and nitrates	3E+3 -	6E+3 5E+3	2E-6 2E-6	8E-9 6E-9	4E-5 -	4E-4 -
72	Hafnium-172	D, see ^{170}Hf W, see ^{170}Hf	1E+3 -	9E+0 Bone surf (2E+1) 4E+1 Bone surf (6E+1)	4E-9 - 2E-8 -	- 3E-11 -	2E-5 -	2E-4 -
72	Hafnium-173	D, see ^{170}Hf W, see ^{170}Hf	5E+3 -	1E+4 1E+4	5E-6 5E-6	2E-8 2E-8	7E-5 -	7E-4 -
72	Hafnium-175	D, see ^{170}Hf W, see ^{170}Hf	3E+3 -	9E+2 Bone surf (1E+3) 1E+3	4E-7 - 5E-7	- 1E-9 2E-9	4E-5 -	4E-4 -
72	Hafnium-177m ²	D, see ^{170}Hf W, see ^{170}Hf	2E+4 -	6E+4 9E+4	2E-5 4E-5	8E-8 1E-7	3E-4 -	3E-3 -
72	Hafnium-178m	D, see ^{170}Hf W, see ^{170}Hf	3E+2 -	1E+0 Bone surf (2E+0) 5E+0 Bone surf (9E+0)	5E-10 - 2E-9 -	- 3E-12 -	3E-6 -	3E-5 -
72	Hafnium-179m	D, see ^{170}Hf W, see ^{170}Hf	1E+3 -	3E+2 Bone surf (6E+2) 6E+2	1E-7 - 3E-7	- 8E-10 8E-10	1E-5 -	1E-4 -
72	Hafnium-180m	D, see ^{170}Hf W, see ^{170}Hf	7E+3 -	2E+4 3E+4	9E-6 1E-5	3E-8 4E-8	1E-4 -	1E-3 -
72	Hafnium-181	D, see ^{170}Hf W, see ^{170}Hf	1E+3 -	2E+2 Bone surf (4E+2) 4E+2	7E-8 - 2E-7	- 6E-10 6E-10	2E-5 -	2E-4 -
72	Hafnium-182m ²	D, see ^{170}Hf W, see ^{170}Hf	4E+4 -	9E+4 1E+5	4E-5 6E-5	1E-7 2E-7	5E-4 -	5E-3 -
72	Hafnium-182	D, see ^{170}Hf W, see ^{170}Hf	2E+2 Bone surf (4E+2) -	8E-1 Bone surf (2E+0) 3E+0 Bone surf (7E+0)	3E-10 - 1E-9 -	- 2E-12 -	- 5E-6 -	- 5E-5 -
72	Hafnium-183 ²	D, see ^{170}Hf W, see ^{170}Hf	2E+4 -	5E+4 6E+4	2E-5 2E-5	6E-8 8E-8	3E-4 -	3E-3 -
72	Hafnium-184	D, see ^{170}Hf W, see ^{170}Hf	2E+3 -	8E+3 6E+3	3E-6 3E-6	1E-8 9E-9	3E-5 -	3E-4 -
73	Tantalum-172 ²	W, all compounds except those given for Y Y, elemental Ta, oxides, hydroxides, halides, carbides, nitrates, and nitrides	4E+4 -	1E+5 1E+5	5E-5 4E-5	2E-7 1E-7	5E-4 -	5E-3 -

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
73	Tantalum-173	W, see ¹⁷² Ta Y, see ¹⁷² Ta	7E+3 -	2E+4 2E+4	8E-6 7E-6	3E-8 2E-8	9E-5 -	9E-4 -
73	Tantalum-174 ²	W, see ¹⁷² Ta Y, see ¹⁷² Ta	3E+4 -	1E+5 9E+4	4E-5 4E-5	1E-7 1E-7	4E-4 -	4E-3 -
73	Tantalum-175	W, see ¹⁷² Ta Y, see ¹⁷² Ta	6E+3 -	2E+4 1E+4	7E-6 6E-6	2E-8 2E-8	8E-5 -	8E-4 -
73	Tantalum-176	W, see ¹⁷² Ta Y, see ¹⁷² Ta	4E+3 -	1E+4 1E+4	5E-6 5E-6	2E-8 2E-8	5E-5 -	5E-4 -
73	Tantalum-177	W, see ¹⁷² Ta Y, see ¹⁷² Ta	1E+4 -	2E+4 2E+4	8E-6 7E-6	3E-8 2E-8	2E-4 -	2E-3 -
73	Tantalum-178	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+4 -	9E+4 7E+4	4E-5 3E-5	1E-7 1E-7	2E-4 -	2E-3 -
73	Tantalum-179	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+4 -	5E+3 9E+2	2E-6 4E-7	8E-9 1E-9	3E-4 -	3E-3 -
73	Tantalum-180m	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+4 -	7E+4 6E+4	3E-5 2E-5	9E-8 8E-8	3E-4 -	3E-3 -
73	Tantalum-180	W, see ¹⁷² Ta Y, see ¹⁷² Ta	1E+3 -	4E+2 2E+1	2E-7 1E-8	6E-10 3E-11	2E-5 -	2E-4 -
73	Tantalum-182m ²	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+5 St wall (2E+5) -	5E+5 -	2E-4 -	8E-7 -	- 3E-3 -	- 3E-2 -
73	Tantalum-182	W, see ¹⁷² Ta Y, see ¹⁷² Ta	8E+2 -	3E+2 1E+2	1E-7 6E-8	5E-10 2E-10	1E-5 -	1E-4 -
73	Tantalum-183	W, see ¹⁷² Ta Y, see ¹⁷² Ta	9E+2 LLI wall (1E+3) -	1E+3 -	5E-7 -	2E-9 -	- 2E-5 -	- 2E-4 -
73	Tantalum-184	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+3 -	5E+3 5E+3	2E-6 2E-6	8E-9 7E-9	3E-5 -	3E-4 -
73	Tantalum-185 ²	W, see ¹⁷² Ta Y, see ¹⁷² Ta	3E+4 -	7E+4 6E+4	3E-5 3E-5	1E-7 9E-8	4E-4 -	4E-3 -
73	Tantalum-186 ²	W, see ¹⁷² Ta Y, see ¹⁷² Ta	5E+4 St wall (7E+4) -	2E+5 -	1E-4 -	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
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 -	- 4E-5	- 4E-4
	Tungsten-187	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)			
74	Tungsten-188	D, all compounds	4E+2 LLI wall (5E+2)	1E+3 -	5E-7 -	2E-9 -	- 7E-6	- 7E-5
75	Rhenium-177 ²	D, all compounds except those given for W	9E+4 St wall (1E+5)	3E+5 -	1E-4 -	4E-7 -	- 2E-3	- 2E-2
		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 -	- 1E-3	- 1E-2
		W, see ¹⁷⁷ Re	-	3E+5	1E-4	4E-7	-	-
75	Rhenium-181	D, see ¹⁷⁷ Re	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
		W, see ¹⁷⁷ Re	-	9E+3	4E-6	1E-8	-	-
75	Rhenium-182 (12.7 h)	D, see ¹⁷⁷ Re	7E+3	1E+4	5E-6	2E-8	9E-5	9E-4
		W, see ¹⁷⁷ Re	-	2E+4	6E-6	2E-8	-	-
75	Rhenium-182 (64.0 h)	D, see ¹⁷⁷ Re	1E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, see ¹⁷⁷ Re	-	2E+3	9E-7	3E-9	-	-
75	Rhenium-184m	D, see ¹⁷⁷ Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ¹⁷⁷ Re	-	4E+2	2E-7	6E-10	-	-
75	Rhenium-184	D, see ¹⁷⁷ Re	2E+3	4E+3	1E-6	5E-9	3E-5	3E-4
		W, see ¹⁷⁷ Re	-	1E+3	6E-7	2E-9	-	-
75	Rhenium-186m	D, see ¹⁷⁷ Re	1E+3 St wall (2E+3)	2E+3 St wall (2E+3)	7E-7 -	- 3E-9	- 2E-5	- 2E-4
		W, see ¹⁷⁷ Re	-	2E+2	6E-8	2E-10	-	-
75	Rhenium-186	D, see ¹⁷⁷ Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ¹⁷⁷ Re	-	2E+3	7E-7	2E-9	-	-
75	Rhenium-187	D, see ¹⁷⁷ Re	6E+5	8E+5 St wall (9E+5)	4E-4 -	- 1E-6	8E-3 -	8E-2 -
		W, see ¹⁷⁷ Re	-	1E+5	4E-5	1E-7	-	-
75	Rhenium-188m ²	D, see ¹⁷⁷ Re	8E+4	1E+5	6E-5	2E-7	1E-3	1E-2
		W, see ¹⁷⁷ Re	-	1E+5	6E-5	2E-7	-	-
75	Rhenium-188	D, see ¹⁷⁷ Re	2E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		W, see ¹⁷⁷ Re	-	3E+3	1E-6	4E-9	-	-
75	Rhenium-189	D, see ¹⁷⁷ Re	3E+3	5E+3	2E-6	7E-9	4E-5	4E-4
		W, see ¹⁷⁷ Re	-	4E+3	2E-6	6E-9	-	-
76	Osmium-180 ²	D, all compounds except those given for W and Y	1E+5	4E+5	2E-4	5E-7	1E-3	1E-2
		W, halides and nitrates	-	5E+5	2E-4	7E-7	-	-
		Y, oxides and hydroxides	-	5E+5	2E-4	6E-7	-	-
76	Osmium-181 ²	D, see ¹⁸⁰ Os	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ¹⁸⁰ Os	-	5E+4	2E-5	6E-8	-	-
		Y, see ¹⁸⁰ Os	-	4E+4	2E-5	6E-8	-	-
76	Osmium-182	D, see ¹⁸⁰ Os	2E+3	6E+3	2E-6	8E-9	3E-5	3E-4
		W, see ¹⁸⁰ Os	-	4E+3	2E-6	6E-9	-	-
		Y, see ¹⁸⁰ Os	-	4E+3	2E-6	6E-9	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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 ($\mu\text{Ci}/\text{m}^3$)			
76	Osmium-185	D, see ^{180}Os W, see ^{180}Os Y, see ^{180}Os	2E+3 - -	5E+2 8E+2 8E+2	2E-7 3E-7 3E-7	7E-10 1E-9 1E-9	3E-5 - -	3E-4 - -
76	Osmium-189m	D, see ^{180}Os W, see ^{180}Os Y, see ^{180}Os	8E+4 - -	2E+5 2E+5 2E+5	1E-4 9E-5 7E-5	3E-7 3E-7 2E-7	1E-3 - -	1E-2 - -
76	Osmium-191m	D, see ^{180}Os W, see ^{180}Os Y, see ^{180}Os	1E+4 - -	3E+4 2E+4 2E+4	1E-5 8E-6 7E-6	4E-8 3E-8 2E-8	2E-4 - -	2E-3 - -
76	Osmium-191	D, see ^{180}Os W, see ^{180}Os Y, see ^{180}Os	2E+3 LLI wall (3E+3) - -	2E+3 - 2E+3 1E+3	9E-7 - 7E-7 6E-7	3E-9 - 2E-9 2E-9	- 3E-5 - -	- 3E-4 - -
76	Osmium-193	D, see ^{180}Os W, see ^{180}Os Y, see ^{180}Os	2E+3 LLI wall (2E+3) - -	5E+3 - 3E+3 3E+3	2E-6 - 1E-6 1E-6	6E-9 - 4E-9 4E-9	- 2E-5 - -	- 2E-4 - -
76	Osmium-194	D, see ^{180}Os W, see ^{180}Os Y, see ^{180}Os	4E+2 LLI wall (6E+2) - -	4E+1 - 6E+1 8E+0	2E-8 - 2E-8 3E-9	6E-11 - 8E-11 1E-11	- 8E-6 - -	- 8E-5 - -
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 - 2E+5 1E+5	6E-5 - 6E-5 5E-5	2E-7 - 2E-7 2E-7	- 6E-4 - -	- 6E-3 - -
77	Iridium-184	D, see ^{182}Ir W, see ^{182}Ir Y, see ^{182}Ir	8E+3 - -	2E+4 3E+4 3E+4	1E-5 1E-5 1E-5	3E-8 5E-8 4E-8	1E-4 - -	1E-3 - -
77	Iridium-185	D, see ^{182}Ir W, see ^{182}Ir Y, see ^{182}Ir	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 ^{182}Ir W, see ^{182}Ir Y, see ^{182}Ir	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 ^{182}Ir W, see ^{182}Ir Y, see ^{182}Ir	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 ^{182}Ir W, see ^{182}Ir Y, see ^{182}Ir	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 ^{182}Ir W, see ^{182}Ir Y, see ^{182}Ir	5E+3 LLI wall (5E+3) - -	5E+3 - 4E+3 4E+3	2E-6 - 2E-6 1E-6	7E-9 - 5E-9 5E-9	- 7E-5 - -	- 7E-4 - -
	Iridium-190m ²	D, see ^{182}Ir	2E+5	2E+5	8E-5	3E-7	2E-3	2E-2

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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 ($\mu\text{Ci}/\text{ml}$)			
		W, see ^{182}Ir	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{182}Ir	-	2E+5	8E-5	3E-7	-	-
77	Iridium-190	D, see ^{182}Ir	1E+3	9E+2	4E-7	1E-9	1E-5	1E-4
		W, see ^{182}Ir	-	1E+3	4E-7	1E-9	-	-
		Y, see ^{182}Ir	-	9E+2	4E-7	1E-9	-	-
77	Iridium-192m	D, see ^{182}Ir	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
		W, see ^{182}Ir	-	2E+2	9E-8	3E-10	-	-
		Y, see ^{182}Ir	-	2E+1	6E-9	2E-11	-	-
77	Iridium-192	D, see ^{182}Ir	9E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		W, see ^{182}Ir	-	4E+2	2E-7	6E-10	-	-
		Y, see ^{182}Ir	-	2E+2	9E-8	3E-10	-	-
77	Iridium-194m	D, see ^{182}Ir	6E+2	9E+1	4E-8	1E-10	9E-6	9E-5
		W, see ^{182}Ir	-	2E+2	7E-8	2E-10	-	-
		Y, see ^{182}Ir	-	1E+2	4E-8	1E-10	-	-
77	Iridium-194	D, see ^{182}Ir	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see ^{182}Ir	-	2E+3	9E-7	3E-9	-	-
		Y, see ^{182}Ir	-	2E+3	8E-7	3E-9	-	-
77	Iridium-195m	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
		Y, see ^{182}Ir	-	2E+4	9E-6	3E-8	-	-
77	Iridium-195	D, see ^{182}Ir	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{182}Ir	-	5E+4	2E-5	7E-8	-	-
		Y, see ^{182}Ir	-	4E+4	2E-5	6E-8	-	-
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
78	Platinum-193m	D, all compounds	3E+3 LLI wall (3E+4)	6E+3	3E-6	8E-9	-	-
			-	-	-	-	4E-5	4E-4
78	Platinum-193	D, all compounds	4E+4 LLI wall (5E+4)	2E+4	1E-5	3E-8	-	-
			-	-	-	-	6E-4	6E-3
78	Platinum-195m	D, all compounds	2E+3 LLI wall (2E+3)	4E+3	2E-6	6E-9	-	-
			-	-	-	-	3E-5	3E-4
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 ^{183}Au	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
		W, see ^{193}Au	-	5E+3	2E-6	8E-9	-	-
		Y, see ^{193}Au	-	5E+3	2E-6	7E-9	-	-
79	Gold-195	D, see ^{193}Au	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{193}Au	-	1E+3	6E-7	2E-9	-	-
		Y, see ^{193}Au	-	4E+2	2E-7	6E-10	-	-
79	Gold-198m	D, see ^{193}Au	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
		Y, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
79	Gold-198	D, see ^{193}Au	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ^{193}Au	-	2E+3	8E-7	3E-9	-	-
		Y, see ^{193}Au	-	2E+3	7E-7	2E-9	-	-
79	Gold-199	D, see ^{193}Au	3E+3	9E+3	4E-6	1E-8	-	-
		LLI wall (3E+3)	-	-	-	-	4E-5	4E-4
		W, see ^{193}Au	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{193}Au	-	4E+3	2E-6	5E-9	-	-
79	Gold-200m	D, see ^{193}Au	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{193}Au	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{193}Au	-	2E+4	1E-6	3E-9	-	-
79	Gold-200 ²	D, see ^{193}Au	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{193}Au	-	8E+4	3E-5	1E-7	-	-
		Y, see ^{193}Au	-	7E+4	3E-5	1E-7	-	-
	Gold-201 ²	D, see ^{193}Au	7E+4	2E+5	9E-5	3E-7	-	-
		St wall (9E+4)	-	-	-	-	1E-3	1E-2
		W, see ^{193}Au	-	2E+5	1E-4	3E-7	-	-
		Y, see ^{193}Au	-	2E+5	9E-5	3E-7	-	-
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 $^{193\text{m}}\text{Hg}$	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see $^{193\text{m}}\text{Hg}$	-	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 $^{193\text{m}}\text{Hg}$	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
		W, see $^{193\text{m}}\text{Hg}$	-	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 $^{193\text{m}}\text{Hg}$	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
		W, see $^{193\text{m}}\text{Hg}$	-	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 $^{193\text{m}}\text{Hg}$	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
		W, see $^{193\text{m}}\text{Hg}$	-	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 $^{193\text{m}}\text{Hg}$	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
		W, see ^{193m} Hg	-	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 ^{193m} Hg	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see ^{193m} Hg	-	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 ^{193m} Hg	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
		W, see ^{193m} Hg	-	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 ^{193m} Hg	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		W, see ^{193m} Hg	-	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
81	Thallium-194 ²	D, all compounds	3E+5	6E+5	2E-4	8E-7	-	-
		St wall (3E+5)	-	-	-	-	4E-3	4E-2
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

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
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 ²⁰⁰ Bi W, see ²⁰⁰ Bi	1E+4 -	3E+4 4E+4	1E-5 2E-5	4E-8 5E-8	2E-4 -	2E-3 -
83	Bismuth-202 ²	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	1E+4 -	4E+4 8E+4	2E-5 3E-5	6E-8 1E-7	2E-4 -	2E-3 -
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 Kidneys (6E+1) -	5E+0 Kidneys (6E+0) 7E-1	2E-9 - 3E-10	- 9E-12 9E-13	- 8E-7 -	- 8E-6 -
83	Bismuth-210	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	8E+2 - -	2E+2 Kidneys (4E+2) 3E+1	1E-7 - 1E-8	- 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 St wall (2E+4) -	8E+2 - 9E-2	3E-7 - 4E-7	1E-9 - 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 -

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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				
			ALI (μCi)	DAC ($\mu\text{Ci}/\text{ml}$)				
84	Polonium-210	D, see ^{209}Po W, see ^{209}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	- -	- -
86	Radon-222	With daughters removed With daughters present	- -	1E+4 1E+2 (or 4 working level months)	4E-6 3E-8 (or 0.33 working level)	1E-8 1E-10	- -	- -
87	Francium-222 ²	D, all compounds	2E+3	5E+2	2E-7	6E-10	3E-5	3E-4
87	Francium-223 ²	D, all compounds	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
88	Radium-223	W, all compounds	5E+0 Bone surf (9E+0)	7E-1 -	3E-10 -	9E-13 -	- 1E-7	- 1E-6
88	Radium-224	W, all compounds	8E+0 Bone surf (2E+1)	2E+0 -	7E-10 -	2E-12 -	- 2E-7	- 2E-6
88	Radium-225	W, all compounds	8E+0 Bone surf (2E+1)	7E-1 -	3E-10 -	9E-13 -	- 2E-7	- 2E-6
88	Radium-226	W, all compounds	2E+0 Bone surf (5E+0)	6E-1 -	3E-10 -	9E-13 -	- 6E-8	- 6E-7
88	Radium-227 ²	W, all compounds	2E+4 Bone surf (2E+4)	1E+4 Bone surf (2E+4)	6E-6 -	- 3E-8	- 3E-4	- 3E-3
88	Radium-228	W, all compounds	2E+0 Bone surf (4E+0)	1E+0 -	5E-10 -	2E-12 -	- 6E-8	- 6E-7
89	Actinium-224	D, all compounds except those given for W and Y	2E+3 LLI wall (2E+3)	3E+1 Bone surf (4E+1)	1E-8 -	- 5E-11	- 3E-5	- 3E-4
		W, halides and nitrates Y, oxides and hydroxides	- -	5E+1 5E+1	2E-8 2E-8	7E-11 6E-11	- -	- -
89	Actinium-225	D, see ^{224}Ac	5E+1 LLI wall (5E+1)	3E-1 Bone surf (5E-1)	1E-10 -	- 7E-13	- 7E-7	- 7E-6
		W, see ^{224}Ac Y, see ^{224}Ac	- -	6E-1 6E-1	3E-10 3E-10	9E-13 9E-13	- -	- -
89	Actinium-226	D, see ^{224}Ac	1E+2 LLI wall (1E+2)	3E+0 Bone surf (4E+0)	1E-9 -	- 5E-12	- 2E-6	- 2E-5

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
		W, see ²²⁴ Ac	-	5E+0	2E-9	7E-12	-	-
		Y, see ²²⁴ Ac	-	5E+0	2E-9	6E-12	-	-
89	Actinium-227	D, see ²²⁴ Ac	2E-1	4E-4	2E-13	-	-	-
		Bone surf (4E-1)	-	8E-4	-	1E-15	5E-9	5E-8
		W, see ²²⁴ Ac	-	2E-3	7E-13	-	-	-
		Bone surf (3E-3)	-	-	-	4E-15	-	-
		Y, see ²²⁴ Ac	-	4E-3	2E-12	6E-15	-	-
89	Actinium-228	D, see ²²⁴ Ac	2E+3	9E+0	4E-9	-	3E-5	3E-4
		Bone surf (2E+1)	-	-	-	2E-11	-	-
		W, see ²²⁴ Ac	-	4E+1	2E-8	-	-	-
		Bone surf (6E+1)	-	-	-	8E-11	-	-
		Y, see ²²⁴ Ac	-	4E+1	2E-8	6E-11	-	-
90	Thorium-226 ²	W, all compounds except those given for Y	5E+3	2E+2	6E-8	2E-10	-	-
		St wall (5E+3)	-	-	-	-	7E-5	7E-4
		Y, oxides and hydroxides	-	1E+2	6E-8	2E-10	-	-
90	Thorium-227	W, see ²²⁶ Th	1E+2	3E-1	1E-10	5E-13	2E-6	2E-5
		Y, see ²²⁶ Th	-	3E-1	1E-10	5E-13	-	-
	Thorium-228	W, see ²²⁶ Th	6E+0	1E-2	4E-12	-	-	-
		Bone surf (1E+1)	-	2E-2	-	3E-14	2E-7	2E-6
		Y, see ²²⁶ Th	-	2E-2	7E-12	2E-14	-	-
90	Thorium-229	W, see ²²⁶ Th	6E-1	9E-4	4E-13	-	-	-
		Bone surf (1E+0)	-	2E-3	-	3E-15	2E-8	2E-7
		Y, see ²²⁶ Th	-	2E-3	1E-12	-	-	-
		Bone surf (3E-3)	-	-	-	4E-15	-	-
90	Thorium-230	W, see ²²⁶ Th	4E+0	6E-3	3E-12	-	-	-
		Bone surf (9E+0)	-	2E-2	-	2E-14	1E-7	1E-6
		Y, see ²²⁶ Th	-	2E-2	6E-12	-	-	-
		Bone surf (2E-2)	-	-	-	3E-14	-	-
90	Thorium-231	W, see ²²⁶ Th	4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
		Y, see ²²⁶ Th	-	6E+3	3E-6	9E-9	-	-
90	Thorium-232	W, see ²²⁶ Th	7E-1	1E-3	5E-13	-	-	-
		Bone surf (2E+0)	-	3E-3	-	4E-15	3E-8	3E-7
		Y, see ²²⁶ Th	-	3E-3	1E-12	-	-	-
		Bone surf (4E-3)	-	-	-	6E-15	-	-
90	Thorium-234	W, see ²²⁶ Th	3E+2	2E+2	8E-8	3E-10	-	-
		LLI wall (4E+2)	-	-	-	-	5E-6	5E-5
		Y, see ²²⁶ Th	-	2E+2	6E-8	2E-10	-	-
91	Protactinium-227 ²	W, all compounds except those given for Y	4E+3	1E+2	5E-8	2E-10	5E-5	5E-4
		Y, oxides and hydroxides	-	1E+2	4E-8	1E-10	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III 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-228 W, see ²²⁷ Pa		1E+3	1E+1	5E-9	-	2E-5	2E-4
		Y, see ²²⁷ Pa	-	Bone surf (2E+1)	-	3E-11	-	-
			-	1E+1	5E-9	2E-11	-	-
91	Protactinium-230 W, see ²²⁷ Pa		6E+2	5E+0	2E-9	7E-12	-	-
		Y, see ²²⁷ Pa	Bone surf (9E+2)	-	-	-	1E-5	1E-4
			-	4E+0	1E-9	5E-12	-	-
91	Protactinium-231 W, see ²²⁷ Pa		2E-1	2E-3	6E-13	-	-	-
		Y, see ²²⁷ Pa	Bone surf (5E-1)	Bone surf (4E-3)	-	6E-15	6E-9	6E-8
			-	4E-3	2E-12	-	-	-
			-	Bone surf (6E-3)	-	8E-15	-	-
91	Protactinium-232 W, see ²²⁷ Pa		1E+3	2E+1	9E-9	-	2E-5	2E-4
		Y, see ²²⁷ Pa	-	Bone surf (6E+1)	-	8E-11	-	-
			-	6E+1	2E-8	-	-	-
			-	Bone surf (7E+1)	-	1E-10	-	-
91	Protactinium-233 W, see ²²⁷ Pa		1E+3	7E+2	3E-7	1E-9	-	-
		Y, see ²²⁷ Pa	LLI wall (2E+3)	-	-	-	2E-5	2E-4
			-	6E+2	2E-7	8E-10	-	-
91	Protactinium-234 W, see ²²⁷ Pa		2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ²²⁷ Pa	-	7E+3	3E-6	9E-9	-	-
92	Uranium-230	D, UF ₆ , UO ₂ F ₂ , UO ₂ (NO ₃) ₂	4E+0	4E-1	2E-10	-	-	-
			Bone surf (6E+0)	Bone surf (6E-1)	-	8E-13	8E-8	8E-7
		W, UO ₃ , UF ₄ , UCl ₄	-	4E-1	1E-10	5E-13	-	-
		Y, UO ₂ , U ₃ O ₈	-	3E-1	1E-10	4E-13	-	-
92	Uranium-231	D, see ²³⁰ U	5E+3	8E+3	3E-6	1E-8	-	-
			LLI wall (4E+3)	-	-	-	6E-5	6E-4
		W, see ²³⁰ U	-	6E+3	2E-6	8E-9	-	-
		Y, see ²³⁰ U	-	5E+3	2E-6	6E-9	-	-
92	Uranium-232	D, see ²³⁰ U	2E+0	2E-1	9E-11	-	-	-
			Bone surf (4E+0)	Bone surf (4E-1)	-	6E-13	6E-8	6E-7
		W, see ²³⁰ U	-	4E-1	2E-10	5E-13	-	-
		Y, see ²³⁰ U	-	8E-3	3E-12	1E-14	-	-
92	Uranium-233	D, see ²³⁰ U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ²³⁰ U	-	7E-1	3E-10	1E-12	-	-
		Y, see ²³⁰ U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-234 ³	D, see ²³⁰ U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ²³⁰ U	-	7E-1	3E-10	1E-12	-	-
		Y, see ²³⁰ U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-235 ³	D, see ²³⁰ U	1E+1	1E+0	6E-10	-	-	-
			Bone surf	Bone surf				

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
			(2E+1)	(2E+0)	-	3E-12	3E-7	3E-6
		W, see ²³⁰ U	-	8E-1	3E-10	1E-12	-	-
		Y, see ²³⁰ U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-236	D, see ²³⁰ U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	-	-	-
		W, see ²³⁰ U	-	8E-1	3E-10	3E-12	3E-7	3E-6
		Y, see ²³⁰ U	-	4E-2	2E-11	1E-12	-	-
						6E-14	-	-
92	Uranium-237	D, see ²³⁰ U	2E+3 LLI wall (2E+3)	3E+3	1E-6	4E-9	-	-
		W, see ²³⁰ U	-	2E+3	7E-7	-	3E-5	3E-4
		Y, see ²³⁰ U	-	2E+3	6E-7	2E-9	-	-
92	Uranium-238 ³	D, see ²³⁰ U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	6E-10	-	-	-
		W, see ²³⁰ U	-	8E-1	3E-10	3E-12	3E-7	3E-6
		Y, see ²³⁰ U	-	4E-2	2E-11	1E-12	-	-
						6E-14	-	-
92	Uranium-239 ²	D, see ²³⁰ U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		W, see ²³⁰ U	-	2E+5	7E-5	2E-7	-	-
		Y, see ²³⁰ U	-	2E+5	6E-5	2E-7	-	-
92	Uranium-240	D, see ²³⁰ U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ²³⁰ U	-	3E+3	1E-6	4E-9	-	-
		Y, see ²³⁰ U	-	2E+3	1E-6	3E-9	-	-
92	Uranium-natural ³ D, see ²³⁰ U		1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	-	-	-
		W, see ²³⁰ U	-	8E-1	3E-10	3E-12	3E-7	3E-6
		Y, see ²³⁰ U	-	5E-2	2E-11	9E-13	-	-
						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-236 (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
93	Neptunium-238	W, all compounds	1E+3	6E+1 Bone surf (2E+2)	3E-8	-	2E-5	2E-4
			-			2E-10	-	-
	Neptunium-239	W, all compounds	2E+3	2E+3	9E-7	3E-9	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III 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)			
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
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 - 2E-11	- 5E-14 6E-14	- 6E-8 -	- 6E-7 -
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 - 8E-12	- 2E-14 2E-14	- 2E-8 -	- 2E-7 -
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 - 7E-12 -	- 2E-14 - 2E-14	- 2E-8 -	- 2E-7 -
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 - 7E-12 -	- 2E-14 - 2E-14	- 2E-8 -	- 2E-7 -
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 - 3E-10 -	- 8E-13 - 1E-12	- 1E-6 -	- 1E-5 -
94	Plutonium-242	W, see ²³⁴ Pu Y, see ²³⁴ Pu	8E-1 Bone surf (1E+0) -	7E-3 Bone surf (1E-2) 2E-2 Bone surf (2E-2)	3E-12 - 7E-12 -	- 2E-14 - 2E-14	- 2E-8 -	- 2E-7 -
94	Plutonium-243	W, see ²³⁴ Pu Y, see ²³⁴ Pu	2E+4 -	4E+4 4E+4	2E-5 2E-5	5E-8 5E-8	2E-4 -	2E-3 -
94	Plutonium-244	W, see ²³⁴ Pu Y, see ²³⁴ Pu	8E-1 Bone surf (2E+0) -	7E-3 Bone surf (1E-2) 2E-2 Bone surf (2E-2)	3E-12 - 7E-12 -	- 2E-14 - 2E-14	- 2E-8 -	- 2E-7 -
94	Plutonium-245	W, see ²³⁴ Pu Y, see ²³⁴ Pu	2E+3 -	5E+3 4E+3	2E-6 2E-6	6E-9 6E-9	3E-5 -	3E-4 -

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col.1 Oral Ingestion ALI (μCi)	Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
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 Bone surf (6E+3)	1E-6	-	5E-4	5E-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	-	-	-
			-	-	-	2E-14	2E-8	2E-7
95	Americium-242m	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	-	-	-
			-	-	-	2E-14	2E-8	2E-7
95	Americium-244m 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
			-	-	-	4E-10	-	-
95	Americium-245	W, all compounds	3E+4	8E+4	3E-5	1E-7	4E-4	4E-3
95	Americium-246m ²	W, all compounds	5E+4 St wall (6E+4)	2E+5	8E-5	3E-7	-	-
			-	-	-	-	8E-4	8E-3
95	Americium-246 ²	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-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	-	-	-
			-	-	-	9E-13	1E-6	1E-5
96	Curium-241	W, all compounds	1E+3	3E+1 Bone surf (4E+1)	1E-8	-	2E-5	2E-4
			-	-	-	5E-11	-	-
96	Curium-242	W, all compounds	3E+1 Bone surf (5E+1)	3E-1 Bone surf (3E-1)	1E-10	-	-	-
			-	-	-	4E-13	7E-7	7E-6
96	Curium-243	W, all compounds	1E+0 Bone surf (2E+0)	9E-3 Bone surf (2E-2)	4E-12	-	-	-
			-	-	-	2E-14	3E-8	3E-7

Title 180
Chapter 1

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)			
96	Curium-244	W, all compounds	1E+0 Bone surf (3E+0)	1E-2 Bone surf (2E-2)	5E-12	- 3E-14	- 3E-8	- 3E-7
96	Curium-245	W, all compounds	7E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	- 2E-14	- 2E-8	- 2E-7
96	Curium-246	W, all compounds	7E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	- 2E-14	- 2E-8	- 2E-7
96	Curium-247	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	- 2E-14	- 2E-8	- 2E-7
96	Curium-248	W, all compounds	2E-1 Bone surf (4E-1)	2E-3 Bone surf (3E-3)	7E-13	- 4E-15	- 5E-9	- 5E-8
96	Curium-249 ²	W, all compounds	5E+4	2E+4 Bone surf (3E+4)	7E-6	- 4E-8	7E-4	7E-3
96	Curium-250	W, all compounds	4E-2 Bone surf (6E-2)	3E-4 Bone surf (5E-4)	1E-13	- 8E-16	- 9E-10	- 9E-9
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	- 1E-14	- 2E-8	- 2E-7
97	Berkelium-249	W, all compounds	2E+2 Bone surf (5E+2)	2E+0 Bone surf (4E+0)	7E-10	- 5E-12	- 6E-6	- 6E-5
97	Berkelium-250	W, all compounds	9E+3	3E+2 Bone surf (7E+2)	1E-7	- 1E-9	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	4E-4	4E-3
98	Californium-246	W, see ²⁴⁴ Cf	4E+2	9E+0	4E-9	1E-11	5E-6	5E-5
		Y, see ²⁴⁴ Cf	-	9E+0	4E-9	1E-11	-	-
98	Californium-248	W, see ²⁴⁴ Cf	8E+0 Bone surf (2E+1)	6E-2 Bone surf (1E-1)	3E-11	- 2E-13	- 2E-7	- 2E-6
		Y, see ²⁴⁴ Cf	-	1E-1	4E-11	1E-13	-	-
98	Californium-249	W, see ²⁴⁴ Cf	5E-1 Bone surf (1E+0)	4E-3 Bone surf (9E-3)	2E-12	- 1E-14	- 2E-8	- 2E-7
		Y, see ²⁴⁴ Cf	-	1E-2 Bone surf (1E-2)	4E-12	- 2E-14	-	-

Title 180
Chapter 1

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release 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 ($\mu\text{Ci}/\text{ml}$)			
98	Californium-250	W, 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 -	-
98	Californium-251	W, 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 -
			-	-	-	2E-14	-	-
98	Californium-252	W, 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	2E+2 Bone surf (4E+2)	2E+0	8E-10	3E-12	-	-
		Y, see ²⁴⁴ Cf	-	-	-	-	5E-6	5E-5
			-	2E+0	7E-10	2E-12	-	-
98	Californium-254	W, see ²⁴⁴ Cf	2E+0	2E-2	9E-12	3E-14	3E-8	3E-7
		Y, see ²⁴⁴ Cf	-	2E-2	7E-12	2E-14	-	-
99	Einsteinium-250	W, all compounds	4E+4	5E+2 Bone surf (1E+3)	2E-7	-	6E-4	6E-3
			-	-	-	2E-9	-	-
	Einsteinium-251	W, all compounds	7E+3	9E+2 Bone surf (1E+3)	4E-7	-	1E-4	1E-3
			-	-	-	2E-9	-	-
99	Einsteinium-253	W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5
99	Einsteinium-254m	W, all compounds	3E+2 LLI wall (3E+2)	1E+1	4E-9	1E-11	-	-
			-	-	-	-	4E-6	4E-5
99	Einsteinium-254	W, all compounds	8E+0 Bone surf (2E+1)	7E-2 Bone surf (1E-1)	3E-11	-	-	-
			-	-	-	2E-13	2E-7	2E-6
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	-	-	-
			-	-	-	3E-13	5E-7	5E-6
101	Mendelevium-257	W, all compounds	7E+3	8E+1 Bone surf (9E+1)	4E-8	-	1E-4	1E-3
			-	-	-	1E-10	-	-
101	Mendelevium-258	W, all compounds	3E+1 Bone surf (5E+1)	2E-1 Bone surf (3E-1)	1E-10	-	-	-
			-	-	-	5E-13	6E-7	6E-6

Any single radionuclide not listed

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
	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	-	-	-
	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,W, 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, Am-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 ore 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 004-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 CA, CB, and CC, 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:

$$\frac{C_A}{DAC_A} + \frac{C_B}{DAC_B} + \frac{C_C}{DAC_C} \leq 1$$

APPENDIX 004-C

QUANTITIES¹ MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μ Ci)*	Radionuclide	Quantity (μ Ci)*
Hydrogen-3	1,000	Manganese-52	100
Beryllium-7	1,000	Manganese-53	1,000
Beryllium-10	1	Manganese-54	100
Carbon-11	1,000	Manganese-56	1,000
Carbon-14	100	Iron-52	100
Fluorine-18	1,000	Iron-55	100
Sodium-22	10	Iron-59	10
Sodium-24	100	Iron-60	1
Magnesium-28	100	Cobalt-55	100
Aluminum-26	10	Cobalt-56	10
Silicon-31	1,000	Cobalt-57	100
Silicon-32	1	Cobalt-58m	1,000
Phosphorus-32	10	Cobalt-58	100
Phosphorus-33	100	Cobalt-60m	1,000
Sulfur-35	100	Cobalt-60	1
Chlorine-36	10	Cobalt-61	1,000
Chlorine-38	1,000	Cobalt-62m	1,000
Chlorine-39	1,000	Nickel-56	100
Argon-39	1,000	Nickel-57	100
Argon-41	1,000	Nickel-59	100
Potassium-40	100	Nickel-63	100
Potassium-42	1,000	Nickel-65	1,000
Potassium-43	1,000	Nickel-66	10
Potassium-44	1,000	Copper-60	1,000
Potassium-45	1,000	Copper-61	1,000
Calcium-41	100	Copper-64	1,000
Calcium-45	100	Copper-67	1,000
Calcium-47	100	Zinc-62	100
Scandium-43	1,000	Zinc-63	1,000
Scandium-44m	100	Zinc-65	10
Scandium-44	100	Zinc-69m	100
Scandium-46	10	Zinc-69	1,000
Scandium-47	100	Zinc-71m	1,000
Scandium-48	100	Zinc-72	100
Scandium-49	1,000	Gallium-65	1,000
Titanium-44	1	Gallium-66	100
Titanium-45	1,000	Gallium-67	1,000
Vanadium-47	1,000	Gallium-68	1,000
Vanadium-48	100	Gallium-70	1,000
Vanadium-49	1,000	Gallium-72	100
Chromium-48	1,000	Gallium-73	1,000
Chromium-49	1,000	Germanium-66	1,000
Chromium-51	1,000	Germanium-67	1,000
Manganese-51	1,000	Germanium-68	10
Manganese-52m	1,000	Germanium-69	1,000

*To convert μ Ci to kBq, multiply the μ Ci value by 37.

APPENDIX 004-C

QUANTITIES¹ MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μ Ci)*	Radionuclide	Quantity (μ Ci)*
Germanium-71	1,000	Rubidium-83	100
Germanium-75	1,000	Rubidium-84	100
Germanium-77	1,000	Rubidium-86	100
Germanium-78	1,000	Rubidium-87	100
Arsenic-69	1,000	Rubidium-88	1,000
Arsenic-70	1,000	Rubidium-89	1,000
Arsenic-71	100	Strontium-80	100
Arsenic-72	100	Strontium-81	1,000
Arsenic-73	100	Strontium-83	100
Arsenic-74	100	Strontium-85m	1,000
Arsenic-76	100	Strontium-85	100
Arsenic-77	100	Strontium-87m	1,000
Arsenic-78	1,000	Strontium-89	10
Selenium-70	1,000	Strontium-90	0.1
Selenium-73m	1,000	Strontium-91	100
Selenium-73	100	Strontium-92	100
Selenium-75	100	Yttrium-86m	1,000
Selenium-79	100	Yttrium-86	100
Selenium-81m	1,000	Yttrium-87	100
Selenium-81	1,000	Yttrium-88	10
Selenium-83	1,000	Yttrium-90m	1,000
Bromine-74m	1,000	Yttrium-90	10
Bromine-74	1,000	Yttrium-91m	1,000
Bromine-75	1,000	Yttrium-91	10
Bromine-76	100	Yttrium-92	100
Bromine-77	1,000	Yttrium-93	100
Bromine-80m	1,000	Yttrium-94	1,000
Bromine-80	1,000	Yttrium-95	1,000
Bromine-82	100	Zirconium-86	100
Bromine-83	1,000	Zirconium-88	10
Bromine-84	1,000	Zirconium-89	10
Krypton-74	1,000	Zirconium-93	1
Krypton-76	1,000	Zirconium-95	10
Krypton-77	1,000	Zirconium-97	100
Krypton-79	1,000	Niobium-88	1,000
Krypton-81	1,000	Niobium-89 (66 min)	1,000
Krypton-83m	1,000	Niobium-89 (122 min)	1,000
Krypton-85m	1,000	Niobium-90	100
Krypton-85	1,000	Niobium-93m	10
Krypton-87	1,000	Niobium-94	1
Krypton-88	1,000	Niobium-95m	100
Rubidium-79	1,000	Niobium-95	100
Rubidium-81m	1,000	Niobium-96	100
Rubidium-81	1,000	Niobium-97	1,000
Rubidium-82m	1,000	Niobium-98	1,000

*To convert μ Ci to kBq, multiply the μ Ci value by 37.

APPENDIX 004-C

QUANTITIES' MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μ Ci)*	Radionuclide	Quantity (μ Ci)*
Molybdenum-90	100	Silver-106	1,000
Molybdenum-93m	100	Silver-108m	1
Molybdenum-93	10	Silver-110m	10
Molybdenum-99	100	Silver-111	100
Molybdenum-101	1,000	Silver-112	100
Technetium-93m	1,000	Silver-115	1,000
Technetium-93	1,000	Cadmium-104	1,000
Technetium-94m	1,000	Cadmium-107	1,000
Technetium-94	1,000	Cadmium-109	1
Technetium-96m	1,000	Cadmium-113m	0.1
Technetium-96	100	Cadmium-113	100
Technetium-97m	100	Cadmium-115m	10
Technetium-97	1,000	Cadmium-115	100
Technetium-98	10	Cadmium-117m	1,000
Technetium-99m	1,000	Cadmium-117	1,000
Technetium-99	100	Indium-109	1,000
Technetium-101	1,000	Indium-110 (69.1m)	1,000
Technetium-104	1,000	Indium-110 (4.9h)	1,000
Ruthenium-94	1,000	Indium-111	100
Ruthenium-97	1,000	Indium-112	1,000
Ruthenium-103	100	Indium-113m	1,000
Ruthenium-105	1,000	Indium-114m	10
Ruthenium-106	1	Indium-115m	1,000
Rhodium-99m	1,000	Indium-115	100
Rhodium-99	100	Indium-116m	1,000
Rhodium-100	100	Indium-117m	1,000
Rhodium-101m	1,000	Indium-117	1,000
Rhodium-101	10	Indium-119m	1,000
Rhodium-102m	10	Tin-110	100
Rhodium-102	10	Tin-111	1,000
Rhodium-103m	1,000	Tin-113	100
Rhodium-105	100	Tin-117m	100
Rhodium-106m	1,000	Tin-119m	100
Rhodium-107	1,000	Tin-121m	100
Palladium-100	100	Tin-121	1,000
Palladium-101	1,000	Tin-123m	1,000
Palladium-103	100	Tin-123	10
Palladium-107	10	Tin-125	10
Palladium-109	100	Tin-126	10
Silver-102	1,000	Tin-127	1,000
Silver-103	1,000	Tin-128	1,000
Silver-104m	1,000	Antimony-115	1,000
Silver-104	1,000	Antimony-116m	1,000
Silver-105	100	Antimony-116	1,000
Silver-106m	100	Antimony-117	1,000

*To convert μ Ci to kBq, multiply the μ Ci value by 37.

APPENDIX 004-C

QUANTITIES' MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μ Ci)*	Radionuclide	Quantity (μ Ci)*
Antimony-118m	1,000	Iodine-133	10
Antimony-119	1,000	Iodine-134	1,000
Antimony-120 (16min.)	1,000	Iodine-135	100
Antimony-120 (5.76d)	100	Xenon-120	1,000
Antimony-122	100	Xenon-121	1,000
Antimony-124m	1,000	Xenon-122	1,000
Antimony-124	10	Xenon-123	1,000
Antimony-125	100	Xenon-125	1,000
Antimony-126m	1,000	Xenon-127	1,000
Antimony-126	100	Xenon-129m	1,000
Antimony-127	100	Xenon-131m	1,000
Antimony-128 (10.4min.)	1,000	Xenon-133m	1,000
Antimony-128 (9.01h)	100	Xenon-133	1,000
Antimony-129	100	Xenon-135m	1,000
Antimony-130	1,000	Xenon-135	1,000
Antimony-131	1,000	Xenon-138	1,000
Tellurium-116	1,000	Cesium-125	1,000
Tellurium-121m	10	Cesium-127	1,000
Tellurium-121	100	Cesium-129	1,000
Tellurium-123m	10	Cesium-130	1,000
Tellurium-123	100	Cesium-131	1,000
Tellurium-125m	10	Cesium-132	100
Tellurium-127m	10	Cesium-134m	1,000
Tellurium-127	1,000	Cesium-134	10
Tellurium-129m	10	Cesium-135m	1,000
Tellurium-129	1,000	Cesium-135	100
Tellurium-131m	10	Cesium-136	10
Tellurium-131	100	Cesium-137	10
Tellurium-132	10	Cesium-138	1,000
Tellurium-133m	100	Barium-126	1,000
Tellurium-133	1,000	Barium-128	100
Tellurium-134	1,000	Barium-131m	1,000
Iodine-120m	1,000	Barium-131	100
Iodine-120	100	Barium-133m	100
Iodine-121	1,000	Barium-133	100
Iodine-123	100	Barium-135m	100
Iodine-124	10	Barium-139	1,000
Iodine-125	1	Barium-140	100
Iodine-126	1	Barium-141	1,000
Iodine-128	1,000	Barium-142	1,000
Iodine-129	1	Lanthanum-131	1,000
Iodine-130	10	Lanthanum-132	100
Iodine-131	1	Lanthanum-135	1,000
Iodine-132m	100	Lanthanum-137	10
Iodine-132	100	Lanthanum-138	100

*To convert μ Ci to kBq, multiply the μ Ci value by 37.

APPENDIX 004-C

QUANTITIES' MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μ Ci)*	Radionuclide	Quantity (μ Ci)*
Lanthanum-140	100	Samarium-146	1
Lanthanum-141	100	Samarium-147	100
Lanthanum-142	1,000	Samarium-151	10
Lanthanum-143	1,000	Samarium-153	100
Cerium-134	100	Samarium-155	1,000
Cerium-135	100	Samarium-156	1,000
Cerium-137m	100	Europium-145	100
Cerium-137	1,000	Europium-146	100
Cerium-139	100	Europium-147	100
Cerium-141	100	Europium-148	10
Cerium-143	100	Europium-149	100
Cerium-144	1	Europium-150 (12.62h)	100
Praseodymium-136	1,000	Europium-150 (34.2y)	1
Praseodymium-137	1,000	Europium-152m	100
Praseodymium-138m	1,000	Europium-152	1
Praseodymium-139	1,000	Europium-154	1
Praseodymium-142m	1,000	Europium-155	10
Praseodymium-142	100	Europium-156	100
Praseodymium-143	100	Europium-157	100
Praseodymium-144	1,000	Europium-158	1,000
Praseodymium-145	100	Gadolinium-145	1,000
Praseodymium-147	1,000	Gadolinium-146	10
Neodymium-136	1,000	Gadolinium-147	100
Neodymium-138	100	Gadolinium-148	0.001
Neodymium-139m	1,000	Gadolinium-149	100
Neodymium-139	1,000	Gadolinium-151	10
Neodymium-141	1,000	Gadolinium-152	100
Neodymium-147	100	Gadolinium-153	10
Neodymium-149	1,000	Gadolinium-159	100
Neodymium-151	1,000	Terbium-147	1,000
Promethium-141	1,000	Terbium-149	100
Promethium-143	100	Terbium-150	1,000
Promethium-144	10	Terbium-151	100
Promethium-145	10	Terbium-153	1,000
Promethium-146	1	Terbium-154	100
Promethium-147	10	Terbium-155	1,000
Promethium-148m	10	Terbium-156m (5.0h)	1,000
Promethium-148	10	Terbium-156m (24.4h)	1,000
Promethium-149	100	Terbium-156	100
Promethium-150	1,000	Terbium-157	10
Promethium-151	100	Terbium-158	1
Samarium-141m	1,000	Terbium-160	10
Samarium-141	1,000	Terbium-161	100
Samarium-142	1,000	Dysprosium-155	1,000
Samarium-145	100	Dysprosium-157	1,000

*To convert μ Ci to kBq, multiply the μ Ci value by 37.

APPENDIX 004-C

QUANTITIES¹ MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μ Ci)*	Radionuclide	Quantity (μ Ci)*
Dysprosium-159	100	Lutetium-178m	1,000
Dysprosium-165	1,000	Lutetium-178	1,000
Dysprosium-166	100	Lutetium-179	1,000
Holmium-155	1,000	Hafnium-170	100
Holmium-157	1,000	Hafnium-172	1
Holmium-159	1,000	Hafnium-173	1,000
Holmium-161	1,000	Hafnium-175	100
Holmium-162m	1,000	Hafnium-177m	1,000
Holmium-162	1,000	Hafnium-178m	0.1
Holmium-164m	1,000	Hafnium-179m	10
Holmium-164	1,000	Hafnium-180m	1,000
Holmium-166m	1	Hafnium-181	10
Holmium-166	100	Hafnium-182m	1,000
Holmium-167	1,000	Hafnium-182	0.1
Erbium-161	1,000	Hafnium-183	1,000
Erbium-165	1,000	Hafnium-184	100
Erbium-169	100	Tantalum-172	1,000
Erbium-171	100	Tantalum-173	1,000
Erbium-172	100	Tantalum-174	1,000
Thulium-162	1,000	Tantalum-175	1,000
Thulium-166	100	Tantalum-176	100
Thulium-167	100	Tantalum-177	1,000
Thulium-170	10	Tantalum-178	1,000
Thulium-171	10	Tantalum-179	100
Thulium-172	100	Tantalum-180m	1,000
Thulium-173	100	Tantalum-180	100
Thulium-175	1,000	Tantalum-182m	1,000
Ytterbium-162	1,000	Tantalum-182	10
Ytterbium-166	100	Tantalum-183	100
Ytterbium-167	1,000	Tantalum-184	100
Ytterbium-169	100	Tantalum-185	1,000
Ytterbium-175	100	Tantalum-186	1,000
Ytterbium-177	1,000	Tungsten-176	1,000
Ytterbium-178	1,000	Tungsten-177	1,000
Lutetium-169	100	Tungsten-178	1,000
Lutetium-170	100	Tungsten-179	1,000
Lutetium-171	100	Tungsten-181	1,000
Lutetium-172	100	Tungsten-185	100
Lutetium-173	10	Tungsten-187	100
Lutetium-174m	10	Tungsten-188	10
Lutetium-174	10	Rhenium-177	1,000
Lutetium-176m	1,000	Rhenium-178	1,000
Lutetium-176	100	Rhenium-181	1,000
Lutetium-177m	10	Rhenium-182 (12.7h)	1,000
Lutetium-177	100	Rhenium-182 (64.0h)	100

*To convert μ Ci to kBq, multiply the μ Ci value by 37.

APPENDIX 004-C

QUANTITIES' MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μ Ci)*	Radionuclide	Quantity (μ Ci)*
Rhenium-184m	10	Gold-195	10
Rhenium-184	100	Gold-198m	100
Rhenium-186m	10	Gold-198	100
Rhenium-186	100	Gold-199	100
Rhenium-187	1,000	Gold-200m	100
Rhenium-188m	1,000	Gold-200	1,000
Rhenium-188	100	Gold-201	1,000
Rhenium-189	100	Mercury-193m	100
Osmium-180	1,000	Mercury-193	1,000
Osmium-181	1,000	Mercury-194	1
Osmium-182	100	Mercury-195m	100
Osmium-185	100	Mercury-195	1,000
Osmium-189m	1,000	Mercury-197m	100
Osmium-191m	1,000	Mercury-197	1,000
Osmium-191	100	Mercury-199m	1,000
Osmium-193	100	Mercury-203	100
Osmium-194	1	Thallium-194m	1,000
Iridium-182	1,000	Thallium-194	1,000
Iridium-184	1,000	Thallium-195	1,000
Iridium-185	1,000	Thallium-197	1,000
Iridium-186	100	Thallium-198m	1,000
Iridium-187	1,000	Thallium-198	1,000
Iridium-188	100	Thallium-199	1,000
Iridium-189	100	Thallium-200	1,000
Iridium-190m	1,000	Thallium-201	1,000
Iridium-190	100	Thallium-202	100
Iridium-192 (73.8d)	1	Thallium-204	100
Iridium-192m (1.4min.)	10	Lead-195m	1,000
Iridium-194m	10	Lead-198	1,000
Iridium-194	100	Lead-199	1,000
Iridium-195m	1,000	Lead-200	100
Iridium-195	1,000	Lead-201	1,000
Platinum-186	1,000	Lead-202m	1,000
Platinum-188	100	Lead-202	10
Platinum-189	1,000	Lead-203	1,000
Platinum-191	100	Lead-205	100
Platinum-193m	100	Lead-209	1,000
Platinum-193	1,000	Lead-210	0.01
Platinum-195m	100	Lead-211	100
Platinum-197m	1,000	Lead-212	1
Platinum-197	100	Lead-214	100
Platinum-199	1,000	Bismuth-200	1,000
Platinum-200	100	Bismuth-201	1,000
Gold-193	1,000	Bismuth-202	1,000
Gold-194	100	Bismuth-203	100

*To convert μ Ci to kBq, multiply the μ Ci value by 37.

APPENDIX 004-C

QUANTITIES' MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μ Ci)*	Radionuclide	Quantity (μ Ci)*
Bismuth-205	100	Protactinium-234	100
Bismuth-206	100	Uranium-230	0.01
Bismuth-207	10	Uranium-231	100
Bismuth-210m	0.1	Uranium-232	0.001
Bismuth-210	1	Uranium-233	0.001
Bismuth-212	10	Uranium-234	0.001
Bismuth-213	10	Uranium-235	0.001
Bismuth-214	100	Uranium-236	0.001
Polonium-203	1,000	Uranium-237	100
Polonium-205	1,000	Uranium-238	100
Polonium-207	1,000	Uranium-239	1,000
Polonium-210	0.1	Uranium-240	100
Astatine-207	100	Uranium-natural	100
Astatine-211	10	Neptunium-232	100
Radon-220	1	Neptunium-233	1,000
Radon-222	1	Neptunium-234	100
Francium-222	100	Neptunium-235	100
Francium-223	100	Neptunium-236 (1.15x10 ⁵ y)	0.001
Radium-223	0.1	Neptunium-236 (22.5h)	1
Radium-224	0.1	Neptunium-237	0.001
Radium-225	0.1	Neptunium-238	10
Radium-226	0.1	Neptunium-239	100
Radium-227	1,000	Neptunium-240	1,000
Radium-228	0.1	Plutonium-234	10
Actinium-224	1	Plutonium-235	1,000
Actinium-225	0.01	Plutonium-236	0.001
Actinium-226	0.1	Plutonium-237	100
Actinium-227	0.001	Plutonium-238	0.001
Actinium-228	1	Plutonium-239	0.001
Thorium-226	10	Plutonium-240	0.001
Thorium-227	0.01	Plutonium-241	0.01
Thorium-228	0.001	Plutonium-242	0.001
Thorium-229	0.001	Plutonium-243	1,000
Thorium-230	0.001	Plutonium-244	0.001
Thorium-231	100	Plutonium-245	100
Thorium-232	100	Americium-237	1,000
Thorium-234	10	Americium-238	100
Thorium-natural	100	Americium-239	1,000
Protactinium-227	10	Americium-240	100
Protactinium-228	1	Americium-241	0.001
Protactinium-230	0.1	Americium-242m	0.001
Protactinium-231	0.001	Americium-242	10
Protactinium-232	1	Americium-243	0.001
Protactinium-233	100	Americium-244m	100
		Americium-244	10

*To convert μ Ci to kBq, multiply the μ Ci value by 37.

APPENDIX 004-C

QUANTITIES¹ MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μ Ci)*	Radionuclide	Quantity (μ Ci)*
Americium-245	1,000	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 I, Columns 1 and 2, of Appendix 004-B to Section 004, rounding to the nearest factor of 10, and constraining the values listed between 37 Bq and 37 MBq (0.001 and 1,000 μ Ci). Values of 3.7 MBq (100 μ Ci) have been assigned for radionuclides having a radioactive half-life in excess of 10^9 years, except rhenium, 37 MBq (1,000 μ Ci), to take into account their low specific activity. NOTE: For purposes of 004.33E, 004.36A, and 004.56A1 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" -- that is, unity.	
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		
Californium-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		
Fermium-253	1		
Fermium-254	10		
Fermium-255	1		
Fermium-257	0.01		
Mendelevium-257	10		
Mendelevium-258	0.01		

*To convert μ Ci to kBq, multiply the μ Ci value by 37.

APPENDIX 004-D

**REQUIREMENTS FOR TRANSFERS OF LOW-LEVEL RADIOACTIVE WASTE INTENDED FOR
DISPOSAL AT LICENSED DISPOSAL FACILITIES AND MANIFESTS**

Section I. - Manifest

A waste generator, collector, or processor who transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste disposal facility must prepare a Manifest reflecting information requested on the following forms, U.S. Nuclear Regulatory Commission (U.S. NRC) U.S. NRC 540, (3-95) (Uniform Low-Level Radioactive Waste Manifest (Shipping Paper) and U.S. Form NRC 541 (3-95) (Uniform Low-Level Radioactive Waste Manifest (Container and Waste Description) and if necessary, on Agency Form NRC 542 (3-95) (Uniform Low-Level Radioactive Waste Manifest (Manifest Index and Regional Compact Tabulation). U.S. NRC 540 (3-95) and U.S. NRC 540A (3-95) must be completed and must physically accompany the pertinent low-level radioactive waste shipment. Upon agreement between shipper and consignee, U.S. Forms U.S. NRC 541 and U.S. NRC 541A and U.S. NRC 542 and U.S. NRC 542A may be completed, transmitted, and stored in electronic media with the capability for producing legible, accurate, and complete records on the respective forms. Licensees are not required by the Agency to comply with the manifesting requirements of this section when they ship:

- (a) Low-Level Waste for processing and expect its return (i.e., for storage under their license) prior to disposal at a licensed land disposal facility;
- (b) Low-Level Waste that is being returned to the licensee who is the "waste generator" or "generator," as defined in this section; or
- (c) Radioactively contaminated material to a "waste processor" that becomes the processor's "residual waste".

For guidance in completing these forms, refer to the instructions that accompany the forms. Copies of manifests required by this appendix may be legible carbon copies, photocopies, or computer printouts that reproduce the data in the format of the uniform manifest.

Forms U.S. NRC 540, U.S. NRC 541, U.S. NRC 541A and U.S. NRC 542 and U.S. NRC 542A and the accompanying instructions, in hard copy, may be obtained from

Department of Health and Human Services Regulation and Licensure
Public Health Assurance Division
301 Centennial Mall South
P.O. Box 95007
Lincoln, Nebraska 68509-5007

This appendix includes information requirements of the Department of Transportation, as codified in 49 CFR part 172. Information on hazardous, medical, or other waste, required to meet Environmental Protection Agency regulations, as codified in 40 CFR parts 259, 261 or elsewhere, is not addressed in this section, and must be provided on the required EPA forms. However, the required EPA forms must accompany the Uniform Low-Level Radioactive Waste Manifest required by this section.

As used in this appendix, the following definitions apply:

"Chelating agent" has the same meaning as that given in Section 001.

"Chemical description" means a description of the principal chemical characteristics of a low-level radioactive waste.

"Computer-readable medium" means that the Agency's computer can transfer the information from the medium into its memory.

"Consignee" means the designated receiver of the shipment of low-level radioactive waste.

"Decontamination facility" means a facility operating under an Agency, U.S. Nuclear Regulatory Commission or Agreement State or license whose principal purpose is decontamination of equipment or materials to accomplish recycle, reuse, or other waste management objectives, and, for purposes of this section, is not considered to be a consignee for low-level waste shipments.

"Disposal container" means a container principally used to confine low-level radioactive waste during disposal operations at a land disposal facility (also see "high integrity container"). Note that for some shipments, the disposal container may be the transport package.

"EPA identification number" means the number received by a transporter following application to the Administrator of EPA as required by 40 CFR part 263.

"Generator" means a licensee operating under an Agency, U.S. Nuclear Regulatory Commission or Agreement State license who (1) is a waste generator as defined in this part, or (2) is the licensee to whom waste can be attributed within the context of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (e.g., waste generated as a result of decontamination or recycle activities).

"High integrity container (HIC)" means a container commonly designed to meet the structural stability requirements of Appendix 004-E, Section II, and to meet Department of Transportation requirements for a Type A package.

U.S. NRC Forms 540, 540A, 541, 541A, 542, and 542A are Forms referenced in this appendix. Licensees need not use originals of these U.S. NRC Forms as long as any substitute forms are equivalent to the original document in respect to content, clarity, size, and location of information. Upon agreement between the shipper and consignee, U.S. NRC Forms 541 (and 541A) and U.S. NRC Forms 542 and (542A) may be completed, transmitted, and stored in electronic media. The electronic media must have the capability for producing legible, accurate, and complete records in the format of the uniform manifest.

"Package" means the assembly of components necessary to ensure compliance with the packaging requirements of DOT regulations, together with its radioactive contents, as presented for transport.

"Physical description" means the items called for on Form U.S. NRC 541 to describe a low-level radioactive waste.

"Residual waste" means low-level radioactive waste resulting from processing or decontamination activities that cannot be easily separated into distinct batches attributable to specific waste generators. This waste is attributable to the processor or decontamination facility, as applicable.

"Shipper" means the licensed entity (i.e., the waste generator, waste collector, or waste processor) who offers low-level radioactive waste for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator.

"Shipping paper" means U.S. NRC 540 and, if required Form U.S. NRC 540A, which includes the information required by DOT in 49 CFR part 172.

"Source material" has the same meaning as that given in Section 001.

"Special nuclear material" has the same meaning as that given in Section 001.

"Uniform Low-Level Radioactive Waste Manifest" or "Uniform Manifest" means the combination of U.S. NRC Forms 540, 541, and if necessary, 542, and their respective continuation sheets as needed, or equivalent.

"Waste collector" means an entity, operating under an Agency, U.S. Nuclear Regulatory Commission or Agreement State license, whose principal purpose is to collect and consolidate waste generated by others, and to transfer this waste, without processing or repackaging the collected waste, to another licensed waste collector, licensed waste processor, or licensed disposal facility.

"Waste description" means the physical, chemical and radiological description of a low-level radioactive waste as called for on Form U.S. NRC 541.

"Waste generator" means an entity, operating under an Agency, U.S. Nuclear Regulatory Commission or Agreement State license, who (1) possesses any material or component that contains radioactivity or is radioactively contaminated for which the licensee foresees no further use, and (2) transfers this material or component to a licensed disposal facility or to a licensed waste collector or processor for handling or treatment prior to disposal. A licensee performing processing or decontamination services may be a "waste generator" if the transfer of low-level radioactive waste from its facility is defined as "residual waste."

"Waste processor" means an entity, operating under an Agency, U.S. Nuclear Regulatory Commission or Agreement State license, whose principal purpose is to process, repackage, or otherwise treat low-level radioactive material or waste generated by others prior to eventual transfer of waste to a licensed low-level radioactive waste disposal facility.

"Waste type" means a waste within a disposal container having a unique physical description (i.e., a specific waste descriptor code or description; or a waste sorbed on or solidified in a specifically defined media).

INFORMATION REQUIREMENTS

A. General Information

The shipper of the low-level radioactive waste, shall provide the following information on the uniform manifest:

1. The name, facility address, and telephone number of the licensee shipping the waste;
2. An explicit declaration indicating whether the shipper is acting as a waste generator, collector, processor, or a combination of these identifiers for purposes of the manifested shipment; and
3. The name, address, and telephone number, or the name and EPA identification number for the carrier transporting the waste.

B. Shipment Information

The shipper of the radioactive waste shall provide the following information regarding the waste shipment on the uniform manifest:

1. The date of the waste shipment;
2. The total number of packages/disposal containers;
3. The total disposal volume and disposal weight in the shipment;
4. The total radionuclide activity in the shipment.

5. The activity of each of the radionuclides H-3, C-14, Tc-99, and I-129 contained in the shipment; and
6. The total masses of U-233, U-235, and plutonium in the form of special nuclear material, and the total mass of uranium and thorium in the form of source material.

C. Disposal Container and Waste Information

The shipper of the radioactive waste shall provide the following information on the uniform manifest regarding the waste and each disposal container of waste in the shipment:

1. An alphabetic or numeric identification that uniquely identifies each disposal container in the shipment;
2. A physical description of the disposal container, including the manufacturer and model of any high integrity container;
3. The volume displaced by the disposal container;
4. The gross weight of the disposal container, including the waste;
5. For waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container;
6. A physical and chemical description of the waste;
7. The total weight percentage of chelating agent for any waste containing more than 0.1% chelating agent by weight, plus the identify of the principal chelating agent;
8. The approximate volume of waste within a container;
9. The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name;
10. The identities and activities of individual radionuclides contained in each container, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material. For discrete waste types (i.e., activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides associated with a disposal container shall be reported;
11. The total radioactivity within each container; and
12. For wastes consigned to a disposal facility, the classification of the waste pursuant to Appendix 004-E, Section I. Waste not meeting the structural stability requirements of Appendix 004-E, Section II(b) must be identified.

D. Uncontainerized Waste Information

The shipper of the radioactive waste shall provide the following information on the uniform manifest regarding a waste shipment delivered without a disposal container:

1. The approximate volume and weight of the waste;
2. A physical and chemical description of the waste;
3. The total weight percentage of chelating agent if the chelating agent exceeds 0.1% by weight, plus the identity of the principal chelating agent;

4. For waste consigned to a disposal facility, the classification of the waste pursuant to Appendix 004-E, Section I. Waste not meeting the structural stability requirements of Appendix 004-E, Section II(b) must be identified.
5. The identities and activities of individual radionuclides contained in the waste, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material; and
6. For wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

E. Multi-Generator Disposal Container Information

This section applies to disposal containers enclosing mixtures of waste originating from different generators. (Note: The origin of the low-level waste resulting from a processor's activities may be attributable to one or more "generators" (including "waste generators") as defined in this section). It also applies to mixtures of wastes shipped in an uncontainerized form, for which portions of the mixture within the shipment originate from different generators.

1. For homogeneous mixtures of waste, such as incinerator ash, provide the waste description applicable to the mixture and the volume of the waste attributed to each generator.
2. For heterogeneous mixtures of waste, such as the combined products from a large compactor, identify each generator contributing waste to the disposal container, and, for discrete waste types (i.e., activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides contained on these waste types within the disposal container. For each generator, provide the following:
 - (a) The volume of waste within the disposal container;
 - (b) A physical and chemical description of the waste, including the solidification agent, if any;
 - (c) The total weight percentage of chelating agents for any disposal container containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;
 - (d) The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name if the media is claimed to meet stability requirements in Appendix E, Section II(b); and
 - (e) Radionuclide identities and activities contained in the waste, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material if contained in the waste.

Section II - Certification

An authorized representative of the waste generator, processor, or collector shall certify by signing and dating the shipment manifest 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 Agency. A collector in signing the certification is certifying that nothing has been done to the collected waste which would invalidate the waste generator's certification.

Section III - Control and Tracking

- A. Any licensee who transfers radioactive waste to a land disposal facility or a licensed waste collector shall comply with the requirements in A.1 through 9 of this section. Any licensee who transfers waste to a licensed waste processor for waste treatment or repackaging of A.4 through 9 of this section. A licensee shall:

1. Prepare all wastes so that the waste is classified according to Appendix 004-E, Section I and meets waste characteristics requirements in, Appendix 004-E, Section II.
2. Label each disposal container (or transport package if potential radiation hazards preclude labeling of the individual disposal container) of waste to identify whether it is Class A waste, Class B waste, Class C waste, or greater than Class C waste, in accordance with Appendix 004-E, Section I.
3. Conduct a quality assurance program to assure compliance with Appendix 004-E, Section I and Section II (the program must include management evaluation of audits);
4. Prepare the Agency Uniform Low-Level Radioactive Waste Manifest as required by this appendix;
5. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either (i) receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
6. Include Forms U.S. NRC 540 and U.S. NRC 540A, if required, with the shipment regardless of the option in Paragraph A.5 of this section;.
7. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by Section 003 of these regulations. This includes those manifests and documents required under the standards for protection against radiation in effect prior to May 30, 1994; and
8. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by Appendix 004-D.
9. 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 appendix, 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 shipper within one week of receipt by returning a signed copy Form U.S. NRC 540.
2. Prepare a new manifest to reflect consolidated shipments that meet the requirements of this appendix. The waste collector shall ensure that, for each container of waste in the shipment, the manifest identifies the generator of that container of waste;
3. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) Receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
4. Include Forms U.S. NRC 540 and NRC 540A, if required, with the shipment regardless of the option chosen in Paragraph B.3 of this section;
5. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by Section 003 of these regulations, and retain information from generator manifest until the license is terminated. This includes those manifests and documents of acknowledgment of receipt required under the standards for protection against radiation in effect prior to May 30, 1994; and

6. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt;
7. 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 appendix, conduct an investigation in accordance with Paragraph E of this appendix; and
8. Notify the shipper and the Agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

C. Any licensed waste processor who treats or repackages waste shall:

1. Acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of Form U.S. NRC 540;
2. Prepare a new manifest that meets the requirements of this appendix. Preparation of the new manifest reflects that the processor is responsible for meeting these requirements. For each container of waste in the shipment, the manifest shall identify the waste generators, the preprocessed waste volume, and other information as required in Paragraph 1.E. of this appendix;
3. Prepare all wastes so that the waste is classified according to Appendix 004-E, Section I, of Appendix 004-D and meets the waste characteristics requirements in Appendix E, Section II;
4. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with Appendix 004-E, Section I and Section III;
5. Conduct a quality assurance program to assure compliance with Appendix 004- E, Section I and II (the program shall include management evaluation of audits);
6. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
7. Include Forms U.S. NRC 540 and NRC 540A, if required, with the shipment regardless of the option chosen in Paragraph C.6 of this section;
8. Retain copies of the original manifests and new manifests and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by Section 003 of these regulations. This includes those manifests and documents of acknowledgment of receipt required under the standards for protection against radiation in effect prior to May 30, 1994; and
9. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by Section 003;
10. For any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this appendix, conduct an investigation in accordance with Paragraph E of this appendix; and
11. Notify the shipper and the Agency when any shipment, or any part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

D. The land disposal facility operator shall:

1. Acknowledge receipt of the waste within one week of receipt by returning, as a minimum, a signed copy of Form U.S. NRC 540 to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. If any discrepancy exists between materials listed on the Uniform Low-Level Radioactive Waste Manifest and materials received, copies or electronic transfer of the affected forms must be returned indicating that discrepancy.
 2. Maintain copies of all completed manifests or equivalent documentation until the license is terminated. This includes those manifests or equivalent documents required under the standards for protection against radiation in effect prior to May 30, 1994.
 3. Notify the shipper and the Agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.
- E. Any shipments 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 Agency. Each licensee who conducts a trace investigation shall file a written report with the Agency within 2 weeks of completion of the investigation.

APPENDIX 004-E

CLASSIFICATION AND CHARACTERISTICS OF LOW-LEVEL RADIOACTIVE WASTE

I. Classification of Radioactive Waste for Land Disposal

- a) **Considerations.** Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides (and their shorter-lived precursors) whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.
- b) **Classes of waste.**
 - 1) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements set forth in Section II. (a). If Class A waste also meets the stability requirements set forth in Section II. (b), it is not necessary to segregate the waste for disposal.
 - 2) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in Section II.
 - 3) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in Section II.
- c) **Classification determined by long-lived radionuclides.** If the radioactive waste contains only radionuclides listed in Table I, classification shall be determined as follows:
 - 1) If the concentration does not exceed 0.1 times the value in Table I, the waste is Class A.
 - 2) If the concentration exceeds 0.1 times the value in Table I, but does not exceed the value in Table I, the waste is Class C.
 - 3) If the concentration exceeds the value in Table I, the waste is not generally acceptable for near surface disposal.
 - 4) For wastes containing mixtures of radionuclides listed in Table I, the total concentration shall be determined by the sum of fractions rule described in Section I. (g).

Table I

Radionuclide	Concentration	
	curie/cubic meter ^a	nanocurie/gram ^b
C-14	8	
C-14 in activated metal	80	
Ni-59 in activated metal	220	
Nb-94 in activated metal	0.2	
Tc-99	3	
I-129	0.08	
Alpha emitting transuranic radionuclides with half-life greater than five years		100
Pu-241		3,500
Cm-242		20,000
Ra-226		100

^aTo convert the Ci/m³ values to gigabecquerel (G bq) per cubic meter, multiply the Ci/m³ value by 37.

^bTo convert the nCi/g values to becquerel (Bq) per gram, multiply the nCi/g value by 37.

d) **Classification determined by short-lived radionuclides.** If the waste does not contain any of the radionuclides listed in Table I classification shall be determined based on the concentrations shown in Table II. However, as specified in Section I. (f), if radioactive waste does not contain any nuclides listed in either Table I or II, it is Class A.

- 1) If the concentration does not exceed the value in Column 1, the waste is Class A.
- 2) If the concentration exceeds the value in Column 1 but does not exceed the value in Column 2, the waste is Class B.
- 3) If the concentration exceeds the value in Column 2 but does not exceed the value in Column 3, the waste is Class C.
- 4) If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.
- 5) For wastes containing mixtures of the radionuclides listed in Table II, the total concentration shall be determined by the sum of fractions rule described in Section I. (g).

Table II

Concentration, curie/cubic meter*			
Radionuclide	Column 1	Column 2	Column 3
Total of all radionuclides with less than 5-year half-life	700	----	----
H-3	40	----	----
Co-60	700	----	----
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600

*AGENCY NOTE: To convert the Ci/m³ value to gigabecquerel (G bq) per cubic meter, multiply the Ci/m³ value by 37. There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in Table II determine the waste to be Class C independent of these radionuclides.

e) **Classification determined by both long- and short-lived radionuclides.** If the radioactive waste contains a mixture of radionuclides, some of which are listed in Table I and some of which are listed in Table II, classification shall be determined as follows:

- 1) If the concentration of a radionuclide listed in Table I is less than 0.1 times the value listed in Table I, the class shall be that determined by the concentration of radionuclides listed in Table II.
- 2) If the concentration of a radionuclide listed in Table I exceeds 0.1 times the value listed in Table I, but does not exceed the value in Table I, the waste shall be Class C, provided the concentration of radionuclides listed in Table II does not exceed the value shown in Column 3 of Table II.

f) **Classification of wastes with radionuclides other than those listed in Tables I and II.** If the waste does not contain any radionuclides listed in either Table I or II, it is Class A.

g) **The sum of the fractions rule for mixtures of radionuclides.** For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column. Example: A waste contains Sr-90 in a concentration of 1.85 TBq/m³ (50 Ci/m³) and Cs-137 in a concentration of 814 GBq/m³ (22 Ci/m³). Since the concentrations both exceed the values in Column 1, Table II, they must be compared to Column 2 values. For Sr-90 fraction, 50/150 = 0.33., for Cs-137 fraction, 22/44 = 0.5; the sum of the fractions = 0.83. Since the sum is less than 1.0, the waste is Class B.

h) **Determination of concentrations in wastes.** The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of

a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as becquerel (nanocurie) per gram.

II. Radioactive Waste Characteristics

a) The following are minimum requirements for all classes of waste and are intended to facilitate handling and provide protection of health and safety of personnel at the disposal site.

1) Wastes shall be packaged in conformance with the conditions of the license issued to the site operator to which the waste will be shipped. Where the conditions of the site license are more restrictive than the provisions of Section 004, the site license conditions shall govern.

2) Wastes shall not be packaged for disposal in cardboard or fiberboard boxes.

3) Liquid waste shall be packaged in sufficient absorbent material to absorb twice the volume of the liquid.

4) Solid waste containing liquid shall contain as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume.

5) Waste shall not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.

6) Waste shall not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste. This does not apply to radioactive gaseous waste packaged in accordance with Section II.(a)(8).

7) Waste must not be pyrophoric. Pyrophoric materials contained in wastes shall be treated, prepared, and packaged to be nonflammable.¹

8) Wastes in a gaseous form shall be packaged at an absolute pressure that does not exceed 1.5 atmospheres at 20°C. Total activity shall not exceed 3.7 TBq (100 Ci) per container.

9) Wastes containing hazardous, biological, pathogenic, or infectious material shall be treated to reduce to the maximum extent practicable the potential hazard from the non-radiological materials.

b) The following requirements are intended to provide stability of the waste. Stability is intended to ensure that the waste does not degrade and affect overall stability of the site through slumping, collapse, or other failure of the disposal unit and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder, since it provides a recognizable and nondispersible waste.

1) Waste shall have structural stability. A structurally stable waste form will generally maintain its physical dimensions and its form, under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, and microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.

2) Notwithstanding the provisions in Section II. (a)(3) and (4), liquid wastes, or wastes containing liquid, shall be converted into a form that contains as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5% of the volume of the waste for waste processed to a stable form.

¹See 001.02 for definition of pyrophoric.

3) Void spaces within the waste and between the waste and its package shall be reduced to the extent practicable.

III. Labeling

Each package of waste shall be clearly labeled to identify whether it is Class A, Class B, or Class C waste, in accordance with Section I.

APPENDIX 004-F

QUANTITIES FOR USE WITH DECOMMISSIONING
(To convert μCi to kBq , multiply the μCi value by 37.)

<u>Material</u>	<u>Microcurie</u>
Americium-241	0.01
Antimony-122	100
Antimony-124	10
Antimony-125	10
Arsenic-73	100
Arsenic-74	10
Arsenic-76	10
Arsenic-77	100
Barium-131	10
Barium-133	10
Barium-140	10
Bismuth-210	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

APPENDIX 004-F

QUANTITIES FOR USE WITH DECOMMISSIONING

(To convert μCi to kBq , multiply the μCi value by 37.)

<u>Material</u>	<u>Microcurie</u>
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1,000
Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
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-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10
Osmium-191m	100
Osmium-191	100
Osmium-193	100
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100

APPENDIX 004-F

QUANTITIES FOR USE WITH DECOMMISSIONING
(To convert μCi to kBq , multiply the μCi value by 37.)

<u>Material</u>	<u>Microcurie</u>
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	0.01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	0.01
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-105	10
Ruthenium-106	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-22	1
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1
Strontium-91	10
Strontium-92	10
Sulfur-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

APPENDIX 004-F

QUANTITIES FOR USE WITH DECOMMISSIONING
 (To convert μCi to kBq , multiply the μCi value by 37.)

<u>Material</u>	<u>Microcurie</u>
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	0.01
Uranium-234	0.01
Uranium-235	0.01
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	0.01

Any radionuclide other than alpha emitting
radionuclides, not listed above or mixtures of

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.

APPENDIX 004-F

QUANTITIES FOR USE WITH DECOMMISSIONING
(To convert μCi to kBq , multiply the μCi value by 37.)

Material

Microcurie

beta emitters of unknown composition 0.1

NOTE: 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" -- that is, unity.

APPENDIX 004-G

CONCENTRATION AND ACTIVITY LIMITS OF NUCLIDES FOR DISPOSAL IN A CITY OR COUNTY LANDFILL DISPOSAL FACILITY

(For use in 004.42)

<u>Nuclides</u>	<u>Concentration Limit (Ci/m³)</u>	<u>Annual Generator Disposal Limit (Ci/yr)</u>
F-18	3E-1	8
Si-31	1E-2	3E+3
Na-24	9E-4	2E-2
P-32	2	5E+1
P-33	10	3E+2
S-35	9	2E+2
Ar-41	3E-1	8
K-42	2E-2	5E-1
Ca-45	4	1E+2
Ca-47	2E-2	5E-1
Sc-46	2E-3	5E-2
Cr-51	6E-1	2E+1
Fe-59	5E-3	1E-1
Co-57	6E-2	2
Co-58	1E-2	3E-1
Zn-65	7E-3	2E-1
Ga-67	3E-1	8
Se-75	5E-2	1
Br-82	2E-3	5E-2
Rb-86	4E-2	1
Sr-85	2E-2	5E-1
Sr-89	8	2E+2
Y-90	4	1E+2
Y-91	4E-1	10
Zr-95	8E-3	2E-1
Nb-95	8E-3	2E-1
Mo-99	5E-2	1

Nuclides	Concentration Limit (Ci/m³)	Annual Generator Disposal Limit (Ci/yr)
Tc-99m	1	3E+1
Rh-106	1	3E+1
Ag-110m	2E-3	5E-2
Cd-115m	2E-1	5
In-111	9E-2	2
In-113m	9	2E+2
Sn-113	6E-2	2
Sn-119	2E+1	5E+2
Sb-124	2E-3	5E-2
Te-129	2E-1	5
I-123	4E-1	1E+1
I-125	7E-1	2E+1
I-131	4E-2	1
I-133	2E-2	5E-1
Xe-127	8E-2	2
Xe-133	1	3E+1
Ba-140	2E-3	5E-2
La-140	2E-3	5E-2
Ce-141	4E-1	1E+1
Ce-144	1E-3	3E-2
Pr-143	6	2E+2
Nd-147	7E-2	2
Yb-169	6E-2	2
Ir-192	1E-2	3E-1
Au-198	3E-2	8E-1
Hg-197	8E-1	2E+1
Tl-201	4E-1	1E+1
Hg-203	1E-1	3

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

For each radionuclide in the mixture, calculate the ratio between the quantity present in the mixture and the limit established in Appendix 004-G for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

Examples: If radionuclides a, b, and c are present in concentrations C_a , C_b , and C_c and if the applicable concentrations are CL_a , CL_b , and CL_c respectively, then the concentrations shall be limited so that the following relationship exists:

$$(C_a/CL_a) + (C_b/CL_b) + (C_c/CL_c) \leq 1$$

If the total curies for radionuclides a, b, and c are represented A_a , A_b , and A_c and the annual curie limit for each radionuclide is AL_a , AL_b , and AL_c then the generator is limited to the following:

$$(A_a/AL_a) + (A_b/AL_b) + (A_c/AL_c) \leq 1$$

APPROVED BY URS, NJ 2100-0104 ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 1.17 HOURS. THIS UNIFORM MANIFEST IS REQUIRED BY NRC TO MEET REPORTING REQUIREMENTS OF FEDERAL AND STATE AGENCIES FOR THE SHIPMENT INFORMATION AND RECORDS MANAGEMENT BRANCH (T-4 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001. AND IT IS THE PAPERWORK REDUCTION PROJECT (2150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

NRC FORM 640 (3-84) UNIFORM LOW-LEVEL RADIOACTIVE WASTE MANIFEST SHIPPING PAPER		U. S. NUCLEAR REGULATORY COMMISSION		SHIPPER - NAME AND FACILITY		SHIPPER ID NUMBER		7 NRC FORM 640 AND 604A PAGE 1 OF _____ PAGE(S) NRC FORM 641 AND 641A _____ PAGE(S) NRC FORM 642 AND 642A _____ PAGE(S) ADDITIONAL INFORMATION _____ PAGE(S)		8 MANIFEST NUMBER: (Use this number on all continuation pages)							
1 EMERGENCY TELEPHONE NUMBER (include Area Code)		USER PERMIT NUMBER		SHIPMENT NUMBER		COLLECTOR		9 CONSIGNEE - Name and Facility Address		CONTACT							
ORGANIZATION		CONTACT		TELEPHONE NUMBER (include Area Code)		TELEPHONE NUMBER (include Area Code)				DATE							
3 IS THIS AN "EXCLUSIVE USE" SHIPMENT? <input type="checkbox"/> YES <input type="checkbox"/> NO		3 TOTAL NUMBER OF PACKAGES IDENTIFIED ON THIS MANIFEST ■■■■■>		6 CARRIER - Name and Address		EPA ID NUMBER		SIGNATURE .. Authorized consignee acknowledging waste receipt		10 CERTIFICATION							
4 DOES EPA REGULATED WASTE REQUIRING A MANIFEST ACCOMPANY THIS SHIPMENT? <input type="checkbox"/> YES <input type="checkbox"/> NO *Yes,* provide Manifest Number ■■■■■>		EPA MANIFEST NUMBER		CONTACT		TELEPHONE NUMBER (include Area Code)		SIGNATURE .. Authorized carrier acknowledging waste receipt		This is to certify that the herein named 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. This also certifies that the materials are classified, packaged, marked and labeled and are in proper condition for transportation and disposal as described in accordance with the requirements of 10 CFR Parts 20 and 61, or equivalent state regulations.							
11 U.S. DEPARTMENT OF TRANSPORTATION DESCRIPTION (including proper shipping name, hazard class, UN ID number, and any additional information)		12 DOT LABEL "RADIOACTIVE"		13 TRANSPORT INDEX		14 PHYSICAL AND CHEMICAL FORM		15 INDIVIDUAL RADIONUCLIDES		16 TOTAL PACKAGE ACTIVITY IN SI UNITS		17 ILS/SCO CLASS		18 TOTAL WEIGHT OR VOLUME (Use appropriate units)		19 IDENTIFICATION NUMBER OF PACKAGE	
FOR CONSIGNEE USE ONLY																	

NRC FORM 640 (3-84)
 SAMPLE FORM

CONSIGNEE ORIGINAL COPY
(MUST ACCOMPANY WASTE IN TRANSIT)

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005 RADIATION SAFETY REQUIREMENTS FOR INDUSTRIAL RADIOGRAPHIC OPERATIONS

005.01 Purpose and Scope.

005.01A This section prescribes requirements for the issuance of licenses or registrations for the industrial use of sources of radiation and radiation safety requirements for persons using these sources of radiation in industrial radiography.

005.01B The provisions and requirements of this section are in addition to, and not in substitution for, other requirements of these regulations. In particular, the general requirements and provisions of Sections 001, 002, 003, 004, 010, 013, 017 and 018, of these regulations apply to applicants, licensees and registrants subject to this section. Sections 003 and 013 of these regulations apply to licensing and transportation of radioactive material and Section 002 applies to registration of radiation machines. Except for sections which are applicable only to sealed radioactive source, radiation machines and sealed radioactive sources are both covered by this section. This regulation does not apply to medical uses of sources of radiation which are addressed in Sections 006, 007 and 009 of these regulations.

005.02 Definitions. As used in this section, the following definitions apply:

"Annual refresher safety training" means a review conducted or provided by the licensee or registrant for its employees on radiation safety aspects of industrial radiography. The review shall include, as a minimum, any results of internal inspections, new procedures or equipment, new or revised regulations, and accidents or errors that have been observed. The review shall also provide opportunities for employees to ask safety questions.

"ANSI" means the American National Standards Institute.

"Associated equipment" means equipment that is used in conjunction with a radiographic exposure device to make radiographic exposures that drives, guides, or comes in contact with the source.¹

"Cabinet radiography" means industrial radiography conducted in an enclosure or cabinet so shielded that radiation levels at every location on the exterior meet the limitations specified in Parts 004.14 A, B and C of these regulations.

"Cabinet x-ray system" means an x-ray system with the x-ray tube installed in an enclosure that is independent of existing architectural structures except the floor. The cabinet x-ray system is intended to contain at least that portion of a material being irradiated, provide radiation attenuation, and exclude personnel from its interior during generation of radiation. Included are all x-ray systems designed primarily for the inspection of carry-on baggage at airline, railroad, and bus terminals, and in similar facilities. An x-ray tube used within a shielded part of a building, or x-ray equipment which may temporarily or occasionally incorporate portable shielding is not considered a cabinet x-ray system.

"Camera" see "Radiographic exposure device."

"Certifiable cabinet x-ray system" means an existing uncertified x-ray system that has been modified to meet the certification requirements specified in 21 CFR 1020.40.

¹e.g., guide tube, control tube, control (drive) cable, removable stop, "J" tube and collimator when used as an exposure head.

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"Certified cabinet x-ray system" means an x-ray system which has been certified in accordance with 21 CFR 1010.2 as being manufactured and assembled pursuant to the provisions of 21 CFR 1020.40.

"Certifying entity" means an independent certifying organization meeting the requirements in Appendix A of this section or a state regulatory program meeting the requirements in Appendix A, Parts II and III of this section."

"Collimator" means a radiation shield that is placed on the end of the guide tube or directly onto a radiographic exposure device to restrict the size of the radiation beam when the sealed source is cranked into position to make a radiographic exposure.

"Control cable" (Drive cable) means the cable that is connected to the source assembly and used to drive the source to and from the exposure location.

"Control drive mechanism" means a device that enables the source assembly to be moved into and out of the exposure device.

"Control tube" means a protective sheath for guiding the control cable. The control tube connects the control drive mechanism to the radiographic exposure device.

"Drive cable" see "Control cable".

"Exposure head" means a device that locates the gamma radiography sealed source in the selected working position.²

"Field station" means a facility where sources of radiation may be stored or used and from which equipment is dispatched.

"Guide tube" (Projection sheath) means a flexible or rigid tube, or, "J" tube, for guiding the source assembly and the attached control cable from the exposure device to the exposure head. The guide tube may also include the connections necessary for attachment to the exposure device and to the exposure head.

"Hands-on experience" means experience in all of those areas considered to be directly involved in the radiography process, and includes taking radiographs, calibration of survey instruments, operational and performance testing of survey instruments and devices, film development, posting of radiation areas, transportation of radiography equipment, posting of records and radiation area surveillance, etc., as applicable. Excessive time spent in only one or two of these areas, such as film development or radiation area surveillance, should not be counted toward the 2000 hours of hands-on experience required for an Radiation Safety Officer in 005.15A2 or the hands-on experience for a radiographer as required by 005.16A.

"Independent certifying organization" means an independent organization that meets all of the criteria of Appendix A to this section.

"Industrial radiography" (Radiography) means the examination of the macroscopic structure of materials by nondestructive methods using sources of ionizing radiation to produce radiographic images.

²An exposure head is also known as a source stop.

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"Permanent radiographic installation" means an enclosed shielded room, cell, or vault, not located at a temporary jobsite, in which radiography is performed.

"Pigtail" see "Source assembly".

"Pill" see "Sealed source."

"Practical examination" means a demonstration through application of the safety rules and principles in industrial radiography including use of all procedures and equipment to be used by radiographic personnel.

"Projection sheath" see "Guide tube".

"Projector" see "Radiographic exposure device".

"Radiation Safety Officer" for industrial radiography" means an individual with the responsibility for the overall radiation safety protection program on behalf of the licensee or registrant and who meets the requirements of 005.15.

"Radiographer" means any individual who performs or who, in attendance at the site where the sources of radiation are being used, personally supervises industrial radiographic operations and who is responsible to the licensee or registrant for assuring compliance with the requirements of the Agency's regulations and the conditions of the license or registration.

"Radiographer's assistant" means any individual who under the direct supervision of a radiographer, uses radiographic exposure devices, sources of radiation, related handling tools, or radiation survey instruments in industrial radiography.

"Radiographer certification" means written approval received from a certifying entity stating that an individual has satisfactorily met the radiation safety, testing, and experience criteria in 005.16.

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

"Radiographic operations" means all activities performed with a radiographic exposure device, or with a radiation machine. Activities include using, transporting (except by common or contract carriers), or storing a temporary job site, performing surveys to confirm the adequacy of boundaries, setting up equipment, and any activity inside restricted area boundaries. Transporting a radiation machine is not considered a radiographic operation.

"Radiography" see "Industrial radiography".

"S-tube" means a tube through which the radioactive source travels when inside a radiographic exposure device.

"Sealed source" see Subsection 001.02.

"Shielded position" means the location within the radiographic exposure device, source changer or storage container which, by manufacturer's design, is the proper location for storage of the sealed source.

"Source assembly" (Pigtail) means an assembly that consists of the sealed source and a connector that attaches the source to the control cable. The source assembly may include a ballstop to secure the source in the shielded position.

"Source changer" means a device designed and used for replacement of sealed sources in radiographic exposure devices. They may also be used for transporting and storing sealed sources.

"Storage area" means any location, facility, or vehicle which is used to store and secure a radiographic exposure device, a radiation machine, sealed source, or a storage container, when it is not used for radiographic operations. Storage areas are locked or have a physical barrier to prevent accidental exposure, tampering, or unauthorized removal of the device, machine, or container.

"Storage container" means a device in which sealed sources or radiation machines are secured or stored.

"Temporary job site" means a location where radiographic operations are performed and where sources of radiation may be stored other than the location(s) of use authorized on the license or registration.

"Underwater radiography" means radiographic operations performed when the radiographic exposure device or radiation machine and/or related equipment are beneath the surface of the water.

005.03 Exemptions.

005.03A Uses of certified and certifiable cabinet x-ray systems are exempt from the requirements of this section except for the following:

005.03A1 For certified and certifiable cabinet x-ray systems, including those designed to allow admittance of individuals:

005.03A1a No registrant shall permit any individual to operate a cabinet x-ray system until the individual has received a copy of and instruction in the operating procedures for the unit. Records that demonstrate compliance with this subsection shall be maintained for Agency inspection until disposal is authorized by the Agency.

005.03A1b Tests for proper operation of interlocks must be conducted and recorded at intervals not to exceed six months. Records of these tests shall be maintained for Agency inspection until disposal is authorized by the Agency.

005.03A1c The registrant shall perform an evaluation of the radiation dose limits to determine compliance with Parts 004.14A, B and C of these regulations, and 21 CFR 1020.40, Cabinet X-ray Systems, at intervals not to exceed one year. Records of these evaluations shall be maintained for Agency inspection for two years after the evaluation.

005.03B Industrial uses of hand-held light intensified imaging devices are exempt from the rules in this section if the dose rate 18 inches from the source of radiation to any individual does not exceed 2 millirem per hour. Devices which exceed this limit shall meet the applicable requirements of this section and the licensing or registration requirements of Sections 002 or 003 of these regulations, as applicable.

005.04 Licensing and Registration Requirements for Industrial Radiography Operations.

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005.04A The Agency will approve an application for specific license for the use of licensed material or a registration for use of radiation machines if the applicant meets the following requirements and pays applicable fees per Section 018:

005.04A1 The applicant satisfies the general requirements specified in Section 002 for radiation machine facilities or Section 003 for radioactive material, as applicable, and any special requirements contained in this section;

005.04A2 The applicant submits an adequate program for training radiographers and radiographer's assistants that meets the requirements of 005.16:

005.04A2a For 2 years after the effective date of these regulations, the applicant may affirm that all individuals acting as industrial radiographers will be certified in radiation safety by a certifying entity before commencing duty as radiographers. This affirmation substitutes for a description of its initial training and examination program for radiographers in the subjects outlined in 005.16G.

005.04A2b After 2 years from the effective date of these regulations, the applicant need not describe the initial training and examination program for radiographers in the subjects outlined in 005.16G.

005.04A3 The applicant submits procedures for verifying and documenting the certification status of radiographers and for ensuring that the certification of individuals acting as radiographers remains valid;

005.04A4 The applicant submits written operating and emergency procedures as described in 005.17;

005.04A5 The applicant submits a description of a program for inspections of the job performance of each radiographer and radiographer's assistant at intervals not to exceed 6 months as described in 005.16E;

005.04A6 The applicant submits a description of the applicant's overall organizational structure as it applies to the radiation safety responsibilities in industrial radiography, including specified delegation of authority and responsibility;

005.04A7 The applicant submits the qualifications of the individual(s) designated as the radiation safety officer as described in 005.15A;

005.04A8 If an applicant intends to perform leak testing of sealed sources or exposure devices containing depleted uranium (DU) shielding, the applicant must describe the procedures for performing the test and the qualifications of the persons(s) authorized to do the leak testing. If the applicant intends to analyze its own wipe samples, the application must include a description of the to be followed. The description must include the:

005.04A8a Methods of collecting the samples;

005.04A8b Qualifications of the individual who analyzes the samples;

005.04A8c Instruments to be used; and

005.04A8d Methods of analyzing the samples

005.04A9 If the applicant intends to perform calibrations of survey instruments and alarming ratemeters, the applicant must describe methods to be used and the experience of the person(s) who will perform the calibrations. All calibrations must be performed according to the procedures described and at the intervals prescribed in 005.08 and 005.19G4.

005.04A10 The applicant identifies and describes the location(s) of all field stations and permanent radiographic installations.

005.14A11 The applicant identifies the location(s) where all records required by this and other Sections of these regulations will be maintained.

005.04A12 If an application includes underwater radiography, a description of:

005.04A12a Radiation safety procedures and radiographer responsibilities unique to the performance of underwater radiography;

005.04A12b Radiographic equipment and radiation safety equipment unique to underwater radiography; and

005.04A12c Methods for gas-tight encapsulation of equipment.

005.05 Performance Requirements for Industrial Radiography Equipment. Equipment used in industrial radiographic operations must meet the following minimum criteria:

005.05A Each radiographic exposure device, source assembly or sealed source, and all associated equipment must meet the requirements specified in American National Standard Institute, N432-1980 "Radiological Safety for the Design and Construction of Apparatus for Gamma Radiography," (published as NBS Handbook 136, issued January 1981). This publication has been incorporated herein by reference and is available for viewing at the Department of Health and Human Services Regulation and Licensure, Public Health Assurance Division, 301 Centennial Mall South, P.O. Box 95007, Lincoln, Nebraska 68509-5007.

005.05B In addition to the requirements specified in 005.05A, the following requirements apply to radiographic exposure devices, source chargers, source assemblies and sealed sources;

005.05B1 The licensee shall ensure that each radiographic exposure device has attached to it a durable, legible, clearly visible label bearing the:

005.05B1a Chemical symbol and mass number of the radionuclide in the device;

005.05B1b Activity and the date on which this activity was last measured;

005.05B1c Model or product code and serial number of the sealed source;

005.05B1d Name of the manufacturer of the sealed source; and

005.05B1e Licensee's name, address, and telephone number.

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005.05B2 Radiographic exposure devices intended for use as Type B packages must meet the applicable transportation requirements of Section 013 of these regulations.

005.05B3 Modification of radiographic exposure devices, source changers, and source assemblies and associated equipment is prohibited, unless approved by the Agency or other approval body.

005.05C In addition to the requirements specified in 005.05A and 005.05B, the following requirements apply to radiographic exposure devices, source assemblies, and associated equipment that allow the source to be moved out of the device for radiographic operations or to source changers;

005.05C1 The coupling between the source assembly and the control cable must be designed in such a manner that the source assembly will not become disconnected if cranked outside the guide tube. The coupling must be such that it cannot be unintentionally disconnected under normal and reasonably foreseeable abnormal conditions.

005.05C2 The device must automatically secure the source assembly when it is cranked back into the fully shielded position within the device. This securing system may only be released by means of a deliberate operation on the exposure device.

005.05C3 The outlet fittings, lock box, and drive cable fittings on each radiographic exposure device must be equipped with safety plugs or covers which must be installed during storage and transportation to protect the source assembly from water, mud, sand or other foreign matter.

005.05C4 Each sealed source or source assembly must have attached to it or engraved on it, a durable, legible, visible label with the words:

"DANGER -- RADIOACTIVE."

The label may not interfere with the safe operation of the exposure device or associated equipment.

005.05C5 The guide tube must be able to withstand a crushing test that closely approximates the crushing forces that are likely to be encountered during use, and be able to withstand a kinking resistance test that closely approximates the kinking forces that are likely to be encountered during use.

005.05C6 Guide tubes must be used when moving the source out of the device.

005.05C7 An exposure head or similar device designed to prevent the source of assembly from passing out of the end of the guide tube must be attached to the outermost end of the guide tube during the industrial radiography operations.

005.05C8 The guide tube exposure head connection must be able to withstand the tensile test for control units specified in ANSI N432-1980.

005.05C9 Source changes must provide a system for ensuring that the source will not be accidentally withdrawn from the changer when connecting or disconnecting the drive cable to or from a source assembly.

005.05D All radiographic exposure devices and associated equipment in use after January 10, 1996, must comply with the requirements of this section; and

005.05E As an exception to 005.05A, equipment used in industrial radiographic operations need not comply with § 8.9.2 (c) of the Endurance Test in American National Standards Institute N432-1980, if the prototype equipment has been tested using a torque value representative of the torque that an individual using the radiography equipment can reasonably exert on the lever or crankshaft of the drive mechanism.

005.06 Limits on External Radiation Levels From Storage Containers and Source Changers. The maximum exposure rate limits for storage containers and source changers are 2 millisieverts (200 mrem) per hour at any exterior surface, and 0.1 millisieverts (10 mrem) per hour at 1 meter from any exterior surface with the sealed source in the shielded position.

005.07 Locking of Sources of Radiation, Storage Containers and Source Changers.

005.07A Each radiographic exposure device must have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position. The exposure device and/or its container must be locked when not under the direct surveillance of a radiographer or a radiographer's assistant except at permanent radiographic installations as stated in 005.21. In addition, during radiographic operations the sealed source assembly must be secured in a shielded position each time the source is returned to that position.³

005.07B Each sealed source storage container and source changer must have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position. Storage containers and source changers must be kept locked when containing sealed sources except when under the direct surveillance of a radiographer or a radiographer's assistant.⁴

005.07C The control panel of each radiation machine shall be equipped with a lock that will prevent the unauthorized use of an x-ray system or the accidental production of radiation. The radiation machine shall be kept locked and the key removed at all times except when under the direct visual surveillance of a radiographer or a radiographer's assistant.

005.08 Radiation Survey Instruments

005.08A The licensee or registrant shall keep sufficient calibrated and operable radiation survey instruments at each location where sources of radiation are present to make the radiation surveys required by this section and by Section 004 of these regulations. Instrumentation required by this section must be capable of measuring a range from 0.02 millisieverts (2 mrem) per hour through 0.01 sievert (1 rem) per hour.

005.08B The licensee or registrant shall have each radiation survey instrument required under 005.08A calibrated:

³If a keyed lock, the key must be removed at all times.

⁴If a keyed lock, the key must be removed at all times.

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005.08B1 At energies appropriate for use and at intervals not to exceed 6 months or after instrument servicing, except for battery changes;

005.08B2 For linear scale instruments, at two points located approximately one-third and two-thirds of full-scale on each scale; for logarithmic scale instruments, at mid-range of each decade, and at two points of at least one decade; and for digital instruments, at 3 points between 0.02 and 10 millisieverts (2 and 1000 mrem) per hour; and

005.08B3 So that an accuracy within plus or minus 20 percent of the true radiation dose rate can be demonstrated at each point checked.

005.08C The licensee or registrant shall maintain records of the results of the instrument calibrations in accordance with 005.25.

005.09 Leak Testing and Replacement of Sealed Sources.

005.09A The replacement of any sealed source fastened to or contained in a radiographic exposure device and leak testing of any sealed source must be performed by persons authorized to do so by the Agency, the U.S. Nuclear Regulatory Commission, or another Agreement State.

005.09B The opening, repair, or modification of any sealed source must be performed by persons specifically authorized to do so by the Agency, the U.S. Nuclear Regulatory Commission, or another Agreement State.

005.09C Testing and recordkeeping requirements.

005.09C1 Each licensee who uses a sealed source shall have the source tested for leakage at intervals not to exceed 6 months. The leak testing of the sources must be performed using a method approved by the Agency, the U.S. Nuclear Regulatory Commission, or by another Agreement State. The wipe sample should be taken from the nearest accessible point to the sealed source where contamination might accumulate. The wipe sample must be analyzed for radioactive contamination. The analysis must be capable of detecting the presence of 185 becquerel (0.005 μ Ci) of radioactive material on the test sample and must be performed by a person specifically authorized by the Agency, the U.S. Nuclear Regulatory Commission, or another Agreement State to perform the analysis.

005.09C2 The licensee shall maintain records of the leak tests in accordance with 005.26.

005.09C3 Unless a sealed source is accompanied by a certificate from the transferor that shows that it has been leak tested within 6 months before the transfer, it may not be used by the licensee until tested for leakage. Sealed sources that are in storage and not in use do not require leak testing, but must be tested before use or transfer to another person if the interval of storage exceeds 6 months.

005.09D Any test conducted pursuant to 005.09B and 005.09C that reveals the presence of 185 becquerel (0.005 μ Ci) or more of removable radioactive material must be considered evidence that the sealed source is leaking. The licensee shall immediately withdraw the equipment involved from use and shall have it decontaminated and repaired or disposed of in accordance with Agency regulations. A report must be filed with the Agency within 5 days of any test with results that exceed the threshold in this part, describing the equipment involved, the tests results, and the corrective action taken.

005.09E Each exposure device using depleted uranium (DU) shielding and an "S" tube configuration must be tested for DU contamination at intervals not to exceed 12 months. The analysis must be capable of detecting the presence of 185 becquerel (0.005 μ Ci) of radioactive material on the test sample and must be performed by a person specifically authorized by the Agency, the U.S. Nuclear Regulatory Commission or another Agreement State to perform the analysis. Should such testing reveal the presence of 185 becquerel (0.005 μ Ci) or more of DU contamination, the exposure device must be removed from use until an evaluation of the wear of the S-tube has been made. Should the evaluation reveal the S-tube is worn through, the device may not be used again. DU shielded devices do not have to be tested for DU contamination while not in use and in storage. Before using or transferring such a device, however, the device must be tested for DU contamination, if the interval of storage exceeds 12 months. A record of the DU leak-test must be made in accordance with 005.26.

005.10 Quarterly Inventory.

005.10A Each licensee or registrant shall conduct a quarterly physical inventory to account for all sources of radiation, and for devices containing depleted uranium received and possessed under the license.

005.10B The licensee or registrant shall maintain records of the quarterly inventory in accordance with 005.27.

005.11 Inspection and Maintenance of Radiation Machines, Radiographic Exposure Devices, Transport and Storage Containers, Associated Equipment, Source Changers, and Survey Instruments.

005.11A The licensee or registrant shall perform visual and operability checks on survey meters, radiation machines, radiographic exposure devices, transport and storage containers, associated equipment and source changers before each day's use, or work shift, to ensure that:

005.11A1 The equipment is in good working condition;

005.11A2 The sources are adequately shielded; and

005.11A3 Required labeling is present.

005.11B Survey instrument operability must be performed using check sources or other appropriate means.

005.11C If equipment problems are found, the equipment must be removed from service until repaired.

005.11D Each licensee or registrant shall have written procedures for and perform inspection and routine maintenance of radiation machines, radiographic exposure devices, source changers, associated equipment, transport and storage containers, and survey instruments at intervals not to exceed 3 months or before the first use thereafter to ensure the proper functioning of components important to safety. If equipment problems are found, the equipment must be removed from service until repaired.

005.11E The licensee's inspection and maintenance program must include procedures to assure that Type B packages are shipped and maintained in accordance with the certificate of compliance or other approval.

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005.11F Records of equipment problems and of any maintenance performed under 005.11 must be made in accordance with 005.29.

005.11G A program for transport container inspection and maintenance limited to radiographic exposure devices, source changers, or packages transporting these devices and meeting the requirements of this subsection or equivalent U.S. Nuclear Regulatory Commission or Agreement State requirement, is deemed to satisfy the requirements of Subsections 013.07 and 013.21.

005.12 Permanent Radiographic Installations.

005.12A Each entrance that is used for personnel access to the high radiation area in a permanent radiographic installation must have either:

005.12A1 An entrance control of the type described in Subsection 004.24 of these regulations that causes the radiation level upon entry into the area to be reduced; or

005.12A2 Both conspicuous visible and audible warning signals to warn of the presence of radiation. The visible sign must be actuated by radiation whenever the source is exposed or the machine is energized. The audible signal must be actuated when an attempt is made to enter the installation while the source is exposed or the machine is energized.

005.12B The alarm system must be tested for proper operation with a radiation source each day before the installation is used for radiographic operations. The test must include a check of both the visible and audible signals. Entrance control devices that reduce the radiation level upon entry as designated in 005.12A1 must be tested monthly. If an entrance control device or an alarm is operating improperly, it must be immediately labeled as defective and repaired within 7 calendar days. The facility may continue to be used during this 7-day period, provided the licensee or registrant implements the continuous surveillance requirements of 005.21 and uses an alarming ratemeter. Test records for entrance controls and audible and visual alarms must be maintained in accordance with 005.30.

005.13 Labeling, Storage, and Transportation.

005.13A The licensee may not use a source changer or a container to store radioactive material unless the source changer or the storage container has securely attached to it a durable, legible, and clearly visible label bearing the standard trefoil radiation caution symbol conventional colors, i.e., magenta, purple or black on a yellow background, having a minimum diameter of 25 mm, and the wording:

CAUTION*
RADIOACTIVE MATERIAL
NOTIFY CIVIL AUTHORITIES [or "NAME OF COMPANY"]

*—or "DANGER"

005.13B The licensee may not transport radioactive material unless the material is packaged, and the package is labeled, marked, and accompanied with appropriate shipping papers in accordance with Section 013 of these regulations.

005.13C Radiographic exposure devices, source changers, storage containers, and radiation machines, must be physically secured to prevent tampering or removal by unauthorized personnel.

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The licensee shall store radioactive material in a manner that will minimize danger from explosion or fire.

005.13D The licensee shall lock and physically secure the transport package containing radioactive material in the transporting vehicle to prevent accidental loss, tampering, or unauthorized removal.

005.13E The licensee's or registrant's name and city or town where the main business office is located shall be prominently displayed with a durable, clearly visible label(s) on both sides of all vehicles used to transport radioactive material or radiation machines for temporary job site use.

Radiation Safety Requirements

005.14 Conducting Industrial Radiographic Operations

005.14A Whenever radiography is performed at a location other than a permanent radiographic installation, the radiographer must be accompanied by at least one other qualified radiographer or an individual who has at a minimum met the requirements of 005.16C. The additional qualified individual shall observe the operations and be capable of providing immediate assistance to prevent unauthorized entry. Radiography may not be performed if only one qualified individual is present.

005.14B All radiographic operations must be conducted in a permanent radiographic installation unless otherwise specifically authorized by the Agency.

005.14C Except when physically impossible, collimators shall be used in industrial radiographic operations that use radiographic exposure devices that allow the source to be moved out of the device.

005.14D A licensee or registrant may conduct underwater radiography only if procedures have been approved by the Agency, the U.S. Nuclear Regulatory Commission, or by another Agreement State.

005.15 Radiation Safety Officer. The Radiation Safety Officer shall ensure that radiation safety activities are being performed in accordance with approved procedures and regulatory requirements in the daily operation of the licensee's or registrant's program.

005.15A The minimum qualifications, training, and experience for Radiation Safety Officer's for industrial radiography are as follows:

005.15A1 Completion of the training and testing requirements of 005.16A;

005.15A2 2000 hours of hands-on experience as a qualified radiographer in industrial radiographic operations; and

005.15A3 Formal training in the establishment and maintenance of a radiation safety protection program.

005.15B The Agency will consider alternatives when the Radiation Safety Officer has appropriate training and experience in the field of ionizing radiation, and in addition, has adequate formal training with respect to the establishment and maintenance of a radiation safety protection program.

005.15C The specific duties and authorities of the Radiation Safety Officer include:

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005.15C1 Establishing and overseeing all operating, emergency, and ALARA procedures as required by Section 004 of these regulations and reviewing them regularly to ensure that they conform to Agency regulations and the license or registration conditions;

005.15C2 Overseeing and approving the training program for radiographic personnel to ensure that appropriate and effective radiation protection practices are taught;

005.15C3 Ensuring that required radiation surveys and leak tests are performed and documented in accordance with the regulations, including any corrective measures when levels of radiation exceed established limits;

005.15C4 Ensuring that personnel monitoring devices are calibrated, if applicable, and used properly; that records are kept of the monitoring results; and that timely notifications are made as required by Section 004 of these regulations; and

005.15C5 Ensuring that operations are conducted safely and for implementing corrective actions including terminating operations.

005.15D Licensees and registrants will have 2 years from the effective date of these regulations to meet the requirements of 005.15A and 005.15B.

005.16 Training.

005.16A The licensee or registrant may not permit any individual to act as a radiographer until the individual:

005.16A1 Has received at least 40 hours of training in the subjects outlined in 005.16G, in addition to on the job training consisting of hands-on experience under the supervision of a radiographer, and is certified through a radiographer certification program by a certifying entity in accordance with the criteria specified in Appendix A of this section. The on the job training shall include a minimum of 2 months (320 hours) of active participation in the performance of industrial radiography utilizing radioactive material and/or 1 month (160 hours) of active participation in the performance of industrial radiography utilizing radiation machines. Individuals performing industrial radiography utilizing radioactive materials and radiation machines must complete both segments of the on the job training (3 months or 480 hours); or

005.16A2 The licensee or registrant may, until 2 years after the effective date of these regulations, allow an individual who has not met the requirements of 005.16A1, to act as a radiographer after the individual has received at least 40 hours of training in the subjects outlined in 005.16G and demonstrated an understanding of the of these subjects by successful completion of a written examination that was previously submitted to and approved by the Agency, the U.S. Nuclear Regulatory Commission, or another Agreement State, in addition to the on the job training, consisting of hands-on experience under the supervision of the radiographer. The on the job training, shall include a minimum of 2 months (320 hours) of active participation in the performance of industrial radiography utilizing radiation material and/or 1 month (160 hours) of active participation in the performance of industrial radiography utilizing radiation machines. Individuals performing industrial radiography utilizing radioactive materials and radiation machines must complete both segments of the on the job training (3 months or 480 hours).

005.16B In addition, the licensee or registrant may not permit any individual to act as a radiographer until the individual:

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005.16B1 Has received copies and instruction in the requirements described in the regulations contained in this section, and applicable sections of Sections 004, 010, 013 of these regulations, in the license or registration under which the radiographer will perform industrial radiography, and the licensee's or registrant's operating and emergency procedures;

005.16B2 Has demonstrated an understanding of items in 005.16B1 by successful completion of a written or oral examination;

005.16B3 Has received training in the use of the registrant's radiation machines, or the licensee's radiographic exposure devices, sealed sources, in the daily inspection of devices and associated equipment, and in the use of radiation survey instruments; and

005.16B4 Has demonstrated understanding of the use of the equipment described in 005.16B3 by successful completion of a practical examination.

005.16C The licensee or registrant may not permit any individual to act as a radiographer's assistant until the individual:

005.16C1 Has received copies of and instruction in the requirements described in the regulations contained in this section, and applicable Sections 004, 010, 013 of these regulations, in the license or registration under which the radiographer's assistant will perform industrial radiography, and the licensee's or registrant's operating and emergency procedures;

005.16C2 Has demonstrated an understanding of items 005.16C1 by successful completion of a written or oral examination;

005.16C3 Under the personal supervision of a radiographer, has received training in the use of the registrant's radiation machines, or the licensee's radiographic exposure devices and sealed sources, in the daily inspection of devices and associated equipment, and in the use of radiation survey instruments; and

005.16C4 Has demonstrated understanding of the use of the equipment described in 005.16C3 by successful completion of a practical examination.

005.16D The licensee or registrant shall provide annual refresher safety training for each radiographer and radiographer's assistant at intervals not to exceed 12 months.

005.16E Except as provided in 005.16E4, the Radiation Safety Officer or designee shall conduct an inspection program of the job performance of each radiographer and radiographer's assistant to ensure that the Agency's regulations, license or registration requirements, and the applicant's operating and emergency procedures are followed. The inspection program must:

005.16E1 Include observation of the performance of each radiographer and radiographer's assistant during an actual industrial radiographic operation, at intervals not to exceed 6 months; and

005.16E2 Provide that, if a radiographer or a radiographer's assistant has not participated in an industrial radiographic operation for more than 6 months since the last inspection, the radiographer must demonstrate knowledge of the training requirements of 005.16B3 and the radiographer's assistant must demonstrate knowledge of the training requirement of 005.16C3 by a practical examination before these individuals can next participate in a radiographic operation.

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005.16E3 The Agency may consider alternatives in those situations where the individual serves as both radiographer and Radiation Safety Officer.

005.16E4 In those operations where a single individual serves as both radiographer and Radiation Safety Officer, and performs all radiography operations, an inspection program is not required.

005.16F The licensee or registrant shall maintain records of the above training to include certification documents, written, oral and practical examinations, refresher safety training and inspections of job performance in accordance with 005.31.

005.16G The licensee or registrant shall include the following subjects required in 005.16A:

005.16G1 Fundamentals of radiation safety including:

005.16G1a Characteristics of gamma and x-radiation;

005.16G1b Units of radiation dose and quantity of radioactivity;

005.16G1c Hazards of exposure to radiation;

005.16G1d Levels of radiation from sources of radiation; and

005.16G1e Methods of controlling radiation dose (time, distance, and shielding);

005.16G2 Radiation detection instruments including:

005.16G2a Use, operation, calibration, and limitations of radiation survey instruments;

005.16G2b Survey techniques; and

005.16G2c Use of personnel monitoring equipment;

005.16G3 Equipment to be used including:

005.16G3a Operation and control of radiographic exposure equipment, remote handling equipment, and storage containers, including pictures or models of source assemblies (pigtailed).

005.16G3b Operation and control of radiation machines

005.16G3c Storage, control, and disposal of sources of radiation; and

005.16G3d Inspection and maintenance of equipment.

005.16G4 The requirements of pertinent state and federal regulations; and

005.16G5 Case histories of accidents in radiography.

005.16H Licensees or registrants will have until 1 year from the effective date of this rule to comply with the additional training requirements specified in 005.16B1 and 005.16C1.

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005.16I Licensees or registrants will have until 2 years after the effective dates of these regulations to comply with the certification requirements specified in 015.16A1. Records of radiographer certification maintained in accordance with 005.31A provide appropriate affirmation of certification requirements specified in 005.16A1.

005.17 Operating and Emergency Procedures

005.17A Operating and emergency procedures must include, as a minimum, instructions in the following:

005.17A1 Appropriate handling and use of sources of radiation so that no person is likely to be exposed to radiation doses in excess of the limits established in Section 004 of these regulations;

005.17A2 Methods and occasions for conducting radiation surveys;

005.17A3 Methods of posting and controlling access to radiographic areas;

005.17A4 Methods and occasions for locking and securing sources of radiation;

005.17A5 Personnel monitoring and the use of personnel monitoring equipment;

005.17A6 Transporting equipment to field locations, including packing of radiographic exposure devices and storage containers in the vehicles, placarding of vehicles when needed, and control of the equipment during transportation as described in Section 013 of these regulations;

005.17A7 The inspection, maintenance, and operability checks of radiographic exposure devices, radiation machines, survey instruments, alarming ratemeters, transport containers, and storage containers;

005.17A8 Steps that must be taken immediately by radiography personnel in the event a pocket dosimeter is found to be off-scale or an alarming ratemeter alarms unexpectedly;

005.17A9 The procedure(s) for identifying and reporting defects and noncompliance, as required by 005.37;

005.17A10 The procedure for notifying proper persons in the event of an accident or incident;

005.17A11 Minimizing exposure of persons in the event of an accident or incident, including a source disconnect, a transport accident, or loss of a source of radiation;

005.17A12 Source recovery procedure if licensee will perform source recoveries; and

005.17A13 Maintenance of records.

005.17B The licensee or registrant shall maintain copies of current operating and emergency procedures in accordance with 005.32 and 005.36.

005.18 Supervision of Radiographers' Assistants

005.18A The radiographer's assistant shall be under the personal supervision of a radiographer when using sources of radiation or conducting radiation surveys required by 005.20B to determine that

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the sealed source has returned to the shielded position or the radiation machine is off after an exposure. The personal supervision must include:

005.18A1 The radiographer's physical presence at the site where the sources of radiation are being used;

005.18A2 The availability of the radiographer to give immediate assistance if required; and

005.18A3 The radiographer's direct observation of the assistant's performance of the operations referred to in this subsection.

005.19 Personnel Monitoring.

005.19A The licensee or registrant may not permit any individual to act as a radiographer or a radiographer's assistant unless, at all times during radiographic operations, each individual wears, on the trunk of the body, a combination of direct reading dosimeter, an alarming ratemeter, and a film badge, TLD, or optically stimulated luminescent dosimeter (OSLD). At permanent radiography installations where other appropriate alarming or warning devices are in routine use, or during radiographic operations using radiation machines, the use of an alarming ratemeter is not required.

005.19A1 Pocket dosimeters must have a range from zero to 2 millisieverts (200 mrem) and must be recharged at the start of each shift. Electronic personal dosimeters may only be used in place of ion-chamber pocket dosimeters.

005.19A2 Each film badge, TLD's and OSLD's must be assigned to and worn by only one individual.

005.19A3 Film badges, TLD's and OSLD's must be exchanged at periods not to exceed one month.

005.19A4 After replacement, each film badge, TLD or OSLD must be returned to the supplier for processing within 14 calendar days of the end of the monitoring period, or as soon as practicable. In circumstances that make it impossible to return each film badge, TLD or OSLD in 14 calendar days, such circumstances must be documented and available for review by the Agency.

005.19B Direct reading dosimeters such as pocket dosimeters or electronic personal dosimeters, must be read and the exposures recorded at the beginning and end of each shift, and records must be maintained in accordance with 005.33.

005.19C Pocket dosimeters, or electronic personal dosimeters, must be checked at periods not to exceed 12 months for correct response to radiation, and records must be maintained in accordance with 005.33. Acceptable dosimeters must read within plus or minus 20 percent of the true radiation exposure.

005.19D If an individual's pocket dosimeter is found to be off-scale, or the electronic personal dosimeter reads greater than 2 millisieverts (200 mrem), the individual's film badge, TLD or OSLD must be sent for processing within 24 hours. In addition, the individual may not resume work associated with the use of sources of radiation until a determination of the individual's radiation exposure has been made. This determination must be made by the Radiation Safety Officer or the

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Radiation Safety Officer's's designee. The results of this determination must be included in the records maintained in accordance with 005.33.

005.19E If a film badge, TLD or OSLD is lost or damaged, the worker shall cease work immediately until a replacement film badge, TLD or OSLD is provided and the exposure is calculated for the time period from issuance to loss or damage of the film badge, TLD or OSLD. The results of the calculated exposure and the time period for which the film badge, TLD or OSLD was lost or damaged must be included in the records maintained in accordance with 005.33.

005.19F Reports received from the film badge, TLD or OSLD processor must be retained in accordance with 005.33.

005.19G Each alarming ratemeter must:

005.19G1 Be checked to ensure that the alarm functions properly before using at the start of each shift;

005.19G2 Be set to give an alarm signal at a preset dose rate of 5 millisieverts per hour (500 mrem/hr); with an accuracy of plus or minus 20 percent of the true radiation dose rate;

005.19G3 Require special means to change the preset alarm function; and

005.19G4 Be calibrated at periods not to exceed 12 months for correct response to radiation. The licensee shall maintain records of alarming ratemeter calibrations in accordance with 005.33.

005.20 Radiation Surveys. The licensee or registrant shall:

005.20A Conduct all surveys with a calibrated and operable radiation survey instrument that meets the requirements of 005.08;

005.20B Conduct a survey of the radiographic exposure device and guide tube after each exposure when approaching the device or the guide tube. The survey must determine that a sealed source has returned to its shielded position before exchanging films, repositioning the exposure head, or dismantling equipment. Radiation machines shall be surveyed after each exposure to determine that the machine is off;

005.20C Conduct a survey of the radiographic exposure device whenever the source is exchanged and whenever a radiographic exposure devices is placed in a storage area as defined in 005.02, to ensure that the sealed source is in its shielded position; and

005.20D Maintain records in accordance with 005.34.

005.21 Surveillance. During each radiographic operation, the radiographer shall ensure continuous direct visual surveillance of the operation to protect against unauthorized entry into a radiation area or a high radiation area, as defined in Section 001 of these regulations, except as permanent radiographic installations where all entryways are locked and the requirements of 005.12 are met.

005.22 Posting. All areas in which industrial radiography is being performed must be conspicuously posted as required by Subsection 004.33 of these regulations. The exceptions listed in Subsection 004.34 of these regulations do not apply to industrial radiographic operations.

Recordkeeping Requirements

005.23 Records for Industrial Radiography. Each licensee or registrant shall maintain a copy of its license or registration, documents incorporated by reference, and amendments to each of these items until superseded by new documents approved by the Agency, or until the Agency terminates the license or registration.

005.24 Records of Receipt and Transfer of Sources of Radiation.

005.24A Each licensee or registrant shall maintain records showing the receipts and transfers of sealed sources, devices for using DU for shielding, and radiation machines, and retain each record for 3 years after it is made.

005.24B These records must include the date, the name of the individual making the record, radionuclide, number of becquerels (curies) or mass (for DU), and manufacturer, model, and serial number of each source of radiation and/or device, as appropriate.

005.25 Records of Radiation Survey Instruments. Each licensee or registrant shall maintain records of the calibrations of its radiation survey instruments that are required under 005.08 and retain each record for 3 years after it is made.

005.26 Records of Leak Testing of Sealed Sources and Devices Containing DU. Each licensee shall maintain records of leak test results for sealed sources and for devices containing DU. The results must be stated in units of becquerels (μCi). The licensee shall retain each record for 3 years after it is made or until the source in storage is removed.

005.27 Records of Quarterly Inventory.

005.27A Each licensee or registrant shall maintain records of the quarterly inventory of sources of radiation, including devices containing depleted uranium as required by 005.10, and retain each record for 3 years from the date of inventory.

005.27B The record must include the date of the inventory, name of the individual conducting the inventory, radionuclide, number of becquerels (curies) or mass (for DU) in each device, location of sources of radiation and/or devices, and manufacturer, model, and serial number of each source of radiation and/or device, as appropriate.

005.28 Utilization Logs.

005.28A Each licensee or registrant shall maintain utilization logs showing for each source of radiation the following information:

005.28A1 A description, including the make, model, and serial number of the radiation machine or the radiographic exposure device, transport, or storage container in which the sealed source is located;

005.28A2 The identity and signature of the radiographer to whom assigned.

005.28A3 The location and dates of use, including the dates removed and returned to storage; and

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005.28A4 For permanent radiographic installations, the dates each radiation machine is energized.

005.28B The licensee or registrant shall retain the logs required by 005.28A for 3 years after the log is made.

005.29 Records of Inspection and Maintenance of Radiation Machines, Radiographic Exposure Devices, Transport and Storage Containers, Associated Equipment, Source Changers, and Survey Instruments.

005.29A Each licensee or registrant shall maintain records specified in 005.11 of equipment problems found in daily checks and quarterly inspections of radiation machines, radiographic exposure devices, transport and storage containers, associated equipment, source changers, and survey instruments; and retain each record for 3 years after it is made.

005.29B The record must include the date of check or inspection, name of inspector, equipment involved, any problems found, and what repair and/or maintenance, if any, was performed.

005.30 Records of Alarm System and Entrance Control Checks at Permanent Radiographic Installations. Each licensee or registrant shall maintain records of alarm systems and entrance control device tests required by 005.12 and retain each record for 3 years after the record is made..

005.31 Records of Training and Certification.

005.31A Each licensee or registrant shall maintain the following records for 3 years:

005.31A1 Records of training of each radiographer and each radiographer's assistant. The record must include radiographer certification documents and verification of certification status, copies of written tests, dates of oral and practical examinations, names of individuals conducting and receiving the oral and practical examinations, and a list of items tested and the results of the oral and practical examinations; and

005.31A2 Records of annual refresher safety training and semi-annual inspections of job performance for each radiographer and each radiographer's assistant. The records must list the topics discussed during the refresher safety training, the dates the annual refresher safety training was conducted, and names of the instructors and attendees. For inspections of job performance, the records must also include a list showing the items checked and any non-compliance observed by the Radiation Safety Officer or designee.

005.32 Copies of Operating and Emergency Procedures. Each licensee or registrant shall maintain a copy of current operating and emergency procedures until the Agency terminates the license or registration. Superseded material must be retained for 3 years after the changes is made.

005.33 Records of Personnel Monitoring.

005.33A Each licensee or registrant shall maintain the following exposure records specified in 005.19:

005.33A1 Direct reading dosimeter readings and yearly operability checks required by 005.19B and 005.19C for 3 years after the record is made;

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005.33A2 Records of alarming ratemeter calibrations 3 years after the record is made;

005.33A3 Reports received from the film badge, TLD or OSLD processor until the Agency terminates the license or registration; and

005.33A4 Records of estimates of exposures as a result of off-scale personal direct reading dosimeters, or lost or damaged film badges, TLD's or OSLD, until the Agency terminates the license or registration.

005.34 Records of Radiation Surveys. Each licensee shall maintain a record of each exposure device survey conducted before the device is placed in storage as specified in 005.20C. Each record must be maintained for 3 years after the record is made.

005.35 Form of Records. Each record required by this section 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 reproducing a clear copy throughout the required retention period. The record may also be stored in electronic media with the capability of 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 or registrant shall maintain adequate safeguards against tampering with and the loss of records.

005.36 Location of Documents and Records.

005.36A Each licensee or registrant shall maintain copies of records required by Section 005 and other applicable Sections of these regulations at the location specified in 005.04A11.

005.36B Each licensee or registrant shall also maintain current copies of the following documents and records sufficient to demonstrate compliance at each applicable field station and each temporary jobsite;

005.36B1 The license or registration authorizing the use of sources of radiation;

005.36B2 A copy of Sections 001, 004, 005 and 010 of these regulations;

005.36B3 Utilization logs for each source of radiation dispatched from the location as required by 005.28;

005.36B4 Records of equipment problems identified in daily checks of equipment as required by 005.29A.;

005.36B5 Records of alarm system and entrance control checks required by 005.30, if applicable;

005.36B6 Records of dosimeter readings as required by 005.33;

005.36B7 Operating and emergency procedures required by 005.32;

005.36B8 Evidence of the latest calibrations and radiation survey instruments in use at the site, as required by 005.25;

005.36B9 Evidence of the latest calibrations of alarming ratemeters and operability checks of dosimeters as required by 005.33;

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005.36B10 Survey records as required by 005.34 and Subsection 004.47 as applicable, for the period of operation at that site;

005.36B11 The shipping papers for the transportation of radioactive materials required by Section 013 of these regulations and;

005.36B12 When operating under reciprocity pursuant to Section 003 or registration pursuant to Section 002 of these regulations, a copy of the applicable State license or registration, or U.S. Nuclear Regulatory Commission license authorizing the use of sources of radiation.

Notifications

005.37 Notifications

005.37A In addition to the reporting requirements specified in Subsection 003.26 and Section 004 of these regulations, each licensee or registrant shall provide a written report to the Agency within 30 days of the occurrence of any of the following incidents involving radiographic equipment:

005.37A1 Unintentional disconnection of the source assembly from the control cable;

005.37A2 Inability to retract the source assembly to its fully shielded position and secure it in this position;

005.37A3 Failure of any component, which is critical to safe operation of the device, to properly perform its intended function; or

005.37A4 An indicator on a radiation machine fails to show that radiation is being produced, an exposure switch fails to terminate production of radiation when turned to the off position, or a safety interlock fails to terminate x-ray production.

005.37B The licensee or registrant shall include the following information in each report submitted under 005.37A, and in each report of overexposure submitted under Subsection 004.58 of these regulations which involves failure of safety components of radiography equipment:

005.37B1 Description of the equipment problem;

005.37B2 Cause of each incident, if known;

005.37B3 Name of the manufacturer and model number of equipment involved in the incident;

005.37B4 Place, date, and time of the incident;

005.37B5 Actions taken to establish normal operations;

005.37B6 Corrective actions taken or planned to prevent recurrence; and

005.37B7 Names and qualifications of personnel involved in the incident.

005.37C Any licensee or registrant conducting radiographic operations or storing sources of radiation at any location not listed on the license or registration for a period in excess of 180 days in a calendar year, shall notify the Agency prior to exceeding the 180 days.

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005.38 Reciprocity.

005.38A All reciprocal recognition of licenses by the Agency will be granted in accordance with Section 003 of these regulations.

005.38B Reciprocal recognition by the Agency of an individual radiographer certification will be granted provided that:

005.38B1 The individual holds a valid certification in the appropriate category issued by a certifying entity, as defined in 005.02;

005.38B2 The requirements and procedures of the certifying entity issuing the certification affords the same or comparable certification standards as those afforded by 005.16A;

005.38B3 The applicant presents the certification to the Agency prior to the entry into the state; and

005.38B4 No escalated enforcement action is pending with the U.S. Nuclear Regulatory Commission or in any other state.

005.38C Certified individuals who are granted reciprocity by the Agency shall maintain the certification upon which the reciprocal recognition was granted, or prior to the expiration of such certification, shall meet the requirements of 005.16A.

005.39 Specific Requirements for Radiographic Personnel Performing Industrial Radiography.

005.39A At a job site, the following shall be supplied by the licensee or registrant:

005.39A1 At least one operable, calibrated survey instrument for each exposure device or radiation machine in use;

005.39A2 A current whole body personnel monitor (TLD, film badge or OSLD) for each person performing radiographic operations;

005.39A3 An operable, calibrated pocket dosimeter with a range of zero to 200 milliroentgens for each person performing radiographic operations;

005.39A4 An operable, calibrated, alarming ratemeter for each person performing radiographic operations using a radiographic exposure device; and

005.39A5 The appropriate barrier ropes and signs.

005.39B Two years after the effective date of these regulations, each radiographer at a job site shall have on their person a valid certification ID card issued by a certifying entity.

005.39C Industrial radiographic operations shall not be performed if any of the items in 005.39A and 005.39B are not available at the job site or are inoperable.

005.39D During an inspection, the Agency may terminate an operation if any of the items in 005.39A and 005.39B are not available or operable, or if the required number of radiographic personnel are not present. Operations shall not be resumed until all required conditions are met.

APPENDIX A

I. Requirements for an Independent Certifying Organization

An independent certifying organization shall:

1. Be an organization such as a society or association, whose members participate in, or have an interest in, the field of industrial radiography;
2. Make its membership available to the general public nationwide. Membership shall not be restricted because of race, color, religion, sex, age, national origin or disability;
3. Have a certification program open to nonmembers, as well as members;
4. Be an incorporated, nationally recognized organization, that is involved in setting national standards of practice within its field of expertise;
5. Have an adequate staff, a viable system for financing its operations, and a policy and decision-making review board;
6. Have a set of written organizational by-laws and policies that provide adequate assurance of lack of conflict of interest and a system for monitoring and enforcing those by-laws and policies;
7. Have a committee, whose members can carry out their responsibilities impartially, to review and approve the certification guidelines and procedures, and to advise the organization's staff in implementing the certification program;
8. Have a committee, whose members can carry out their responsibilities impartially, to review complaints against certified individuals and to determine appropriate sanctions;
9. Have written procedures describing all aspects of its certification program, maintain records of the current status of each individual's certification and the administration of its certification program;
10. Have procedures to ensure that certified individuals are provided due process with respect to the administration of its certification program, including the process of becoming certified and any sanctions imposed against certified individuals;
11. Have procedures for proctoring examinations, including qualifications for proctors. These procedures must ensure that the individuals proctoring each examination are not employed by the same company or corporation (or a wholly-owned subsidiary of such company or corporation) as any of the examinees;
12. Exchange information about certified individuals with the U.S. Nuclear Regulatory Commission and other independent certifying organizations and/or Agreement States and allow periodic review of its certification program and related records; and
13. Provide a description to the Agency of its procedures for choosing examination sites and for providing an appropriate examination environment.

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II. Requirements for Certification Programs.

All certification programs must:

1. Require applicants for certification to (a) receive training in the topics set forth in 005.16G or equivalent State or U.S. Nuclear Regulatory Commission regulations, and (b) satisfactorily complete a written examination covering these topics;
2. Require applicants for certification to provide documentation that demonstrates that the applicant has:
 - a. received training in the topics set forth in 005.16G or equivalent State or U.S. Nuclear Regulatory Commission regulations;
 - b. satisfactorily completed a minimum period of on the job training as specified in 005.16A; and
 - c. received verification by a State licensee or registrant or a U.S. Nuclear Regulatory Commission licensee that the applicant has demonstrated the capability of independently working as a radiographer.
3. Include procedures to ensure that all examination questions are protected from disclosure;
4. Include procedures for denying an application and revoking, suspending, and reinstating a certification;
5. Provide a certification period of not less than 3 years nor more than 5 years;
6. Include procedures for renewing certifications and, if the procedures allow renewals without examination, require evidence of recent full-time employment and annual refresher training; and
7. Provide a timely response to inquiries, by telephone or letter, from members of the public, about an individual's certification status.

III. Requirements for Written Examinations

All examinations must be:

1. Designed to test an individual's knowledge and understanding of the topics listed in 005.16G or equivalent State or U.S. Nuclear Regulatory Commission requirements;
2. Written in multiple-choice format;
3. Have test items drawn from a question bank containing psychometrically valid questions based on the material in 005.16G.