

Chapter 246-221 WAC

RADIATION PROTECTION STANDARDS

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WAC

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WAC 246-221-001 Purpose and scope. (1) This chapter establishes standards for protection against radiation hazards. Except as otherwise specifically provided, this chapter applies to all licensees or registrants. The requirements of this chapter are designed to control the receipt, possession, use, transfer, and disposal of sources of radiation by any licensee or registrant so the total dose to an individual, including doses resulting from all sources of radiation other than background radiation, does not exceed the standards for protection against radiation prescribed in this chapter.

(2) The limits in this chapter do not apply to doses due to background radiation, to exposure of patients to radiation for the purpose of medical diagnosis or therapy, to exposure from individuals administered radioactive material and released under chapter 246-240 WAC, or to voluntary participation in medical research programs.

(3) Nothing in this chapter shall be interpreted as limiting actions that may be necessary to protect health and safety in an emergency.

(4) The definitions contained in WAC 246-220-010 also apply to this chapter. WAC 246-220-007, Statement of philosophy, is directly applicable to this chapter.

[Statutory Authority: RCW 70.98.050. WSR 06-05-019, § 246-221-001, filed 2/6/06, effective 3/9/06; WSR 98-13-037, § 246-221-001, filed 6/8/98, effective 7/9/98; WSR 94-01-073, § 246-221-001, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-001, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-001, filed 12/27/90, effective 1/31/91; Order 1095, § 402-24-010, filed 2/6/76; Order 1, § 402-24-010, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-005 Radiation protection programs. (1) Each specific licensee shall develop, document, and implement a radiation protection program sufficient to ensure compliance with the provisions of this chapter.

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

(3) The licensee shall review the radiation protection program content and implementation at the frequency specified in the license.

(4) To implement the ALARA requirements of subsection (2) of this section, and notwithstanding the requirements of WAC 246-221-060, a constraint on air emission of radioactive material to the environment, excluding radon-220, radon-222 and their 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 0.1 mSv (10 mrem) per year from these emissions. This dose constraint does not apply to sealed sources or to accelerators less than 200MeV. If a licensee subject to this requirement exceeds this dose constraint, the licensee

shall report the exceedance as provided in WAC 246-221-260 and promptly take appropriate corrective action to ensure against recurrence.

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

(a) The provisions of the program; and

(b) Audits, where required, and other reviews of program content and implementation.

[Statutory Authority: RCW 70.98.050. WSR 01-05-110, § 246-221-005, filed 2/21/01, effective 3/24/01; WSR 99-15-105, § 246-221-005, filed 7/21/99, effective 8/21/99; WSR 94-01-073, § 246-221-005, filed 12/9/93, effective 1/9/94.]

WAC 246-221-010 Occupational dose limits for adults. (1) The licensee or registrant shall control the occupational dose to individual adults, except for planned special exposures pursuant to WAC 246-221-030, to the following dose limits:

(a) An annual limit, which is the more limiting of:

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

(ii) The sum of the effective dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.50 Sv (50 rem).

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

(i) A lens dose equivalent of 0.15 Sv (15 rem); and

(ii) A shallow dose equivalent of 0.50 Sv (50 rem) to the skin of the whole body or to the skin of any extremity.

(2) Doses received in excess of the annual limits, including doses received during accidents, emergencies, and planned special exposures, must be subtracted from the limits specified in WAC 246-221-030 for planned special exposures that the individual may receive during the current year and during the individual's lifetime.

(3) When the external exposure is determined by measurement with an external personal monitoring device, the deep-dose equivalent must be used in place of the effective dose equivalent, unless the effective dose equivalent is determined by a dosimetry method approved by the NRC or the department. The assigned deep-dose equivalent must be for the part of the body receiving the highest exposure. The assigned shallow dose equivalent shall be the dose averaged over the contiguous ten square centimeters of skin receiving the highest exposure. The

deep dose equivalent, lens 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 the individual monitoring are unavailable.

(4) Derived air concentration (DAC) and annual limit on intake (ALI) values are specified in WAC 246-221-290 and may be used to determine the individual's dose and to demonstrate compliance with the occupational dose limits.

(5) 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.

(6) 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 during the current year as determined in accordance with WAC 246-221-020.

[Statutory Authority: RCW 70.98.050. WSR 14-01-077, § 246-221-010, filed 12/16/13, effective 1/16/14; WSR 04-23-093, § 246-221-010, filed 11/17/04, effective 12/18/04; WSR 01-05-110, § 246-221-010, filed 2/21/01, effective 3/24/01; WSR 94-01-073, § 246-221-010, filed

12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-010, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-010, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-020, filed 12/11/86. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-020, filed 12/8/80; Order 1095, § 402-24-020, filed 2/6/76; Order 1, § 402-24-020, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-015 Compliance with requirements for summation of external and internal doses. (1) If the licensee is required to monitor under both WAC 246-221-090 and 246-221-100, the licensee shall demonstrate compliance with the dose limits by summing external and internal doses. If the licensee is required to monitor only under WAC 246-221-090 or only under WAC 246-221-100, 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 under subsections (2), (3), and (4) of this section. 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.

(2) **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:

(a) The sum of the fractions of the inhalation ALI for each radionuclide; or

(b) The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by two thousand; or

(c) 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 ten percent of the maximum weighted value of H_{50} , that is, $w_T H_{T,50}$, per unit intake for any organ or tissue.

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

(4) **Intake through wounds or absorption through skin.** The licensee 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 this section.

(5) **External dose from airborne radioactive material.** Licensees shall, when determining the dose from airborne radioactive material, include the contribution to the deep dose equivalent, lens dose equivalent, and shallow dose equivalent from external exposure to the radioactive cloud. 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 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.

[Statutory Authority: RCW 70.98.050. WSR 01-05-110, § 246-221-015, filed 2/21/01, effective 3/24/01; WSR 94-01-073, § 246-221-015, filed 12/9/93, effective 1/9/94.]

WAC 246-221-020 Determination of prior occupational dose. (1) For each individual who is likely to receive, in a year, an occupational dose requiring monitoring pursuant to WAC 246-221-090 and 246-221-100, the licensee or registrant shall:

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

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

(2) Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant shall determine:

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

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

(3) In complying with the requirements of subsection (1) of this section, a licensee or registrant may:

(a) 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

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

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

(4) The licensee or registrant shall record the exposure history, as required by subsection (1) of this section, on Form RHF-4A, or oth-

er clear and legible record, of all the information required on that form. The form or record shall show each period in which the individual received occupational exposure to radiation or radioactive material and shall be signed by the individual who received the exposure. For each period for which the licensee or registrant obtains reports, the licensee or registrant shall use the dose shown in the report in preparing Form RHF-4A. For any period in which the licensee or registrant does not obtain a report, the licensee or registrant shall place a notation on Form RHF-4A indicating the periods of time for which data are not available.

(5) Licensees or registrants are not required to reevaluate the separate external dose equivalents and internal committed dose equivalents or intakes of radionuclides assessed under the regulations in effect before January 1, 1994. Further, occupational exposure histories obtained and recorded on Form RHF-4 before January 1, 1994, would not have included effective dose equivalent, but may be used in the absence of specific information on the intake of radionuclides by the individual.

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

(a) In establishing administrative controls under WAC 246-221-010(6) for the current year, that the allowable dose limit for the individual is reduced by 12.5 mSv (1.25 rem) for each calendar quarter for which records were unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure; and

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

(7) The licensee or registrant shall retain the records on Form RHF-4A or equivalent until the department terminates each pertinent license requiring this record. The licensee or registrant shall retain records used in preparing Form RHF-4 or RHF-4A for three years after the record is made.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-221-020, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-221-020, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-221-020, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-020, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-020, filed 12/27/90, effective 1/31/91. Statutory

Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-024, filed 12/8/80; Order 1095, § 402-24-024, filed 2/6/76.]

WAC 246-221-030 Requirements for planned special exposures. A licensee or registrant may authorize an adult worker to receive doses in addition to and accounted for separately from the doses received under the limits specified in WAC 246-221-010 provided that each of the following conditions is satisfied:

(1) The licensee or registrant authorizes a planned special exposure only in an exceptional situation when alternatives that might avoid the dose estimated to result from the planned special exposure are unavailable or impractical.

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

(3) Before a planned special exposure, the licensee or registrant ensures that each individual involved is:

(a) Informed of the purpose of the planned operation; and

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

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

(4) Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant ascertains prior doses as required by WAC 246-221-020(2) during the lifetime of the individual for each individual involved.

(5) Subject to WAC 246-221-010(2), the licensee or registrant shall not authorize a planned special exposure that would cause an individual to receive a dose from all planned special exposures and all doses in excess of the limits to exceed:

(a) The numerical values of any of the dose limits in WAC 246-221-010(1) in any year; and

(b) Five times the annual dose limits in WAC 246-221-010(1) during the individual's lifetime.

(6) The licensee or registrant maintains records that describe:

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

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

(c) What actions were necessary;

(d) Why the actions were necessary;

(e) What precautions were taken to assure that doses were maintained ALARA; and

(f) What individual and collective doses were expected to result.

(7) The licensee or registrant records the best estimate of the dose resulting from the planned special exposure in the individual's record and informs the individual, in writing, of the dose within thirty days from the date of the planned special exposure. The dose from planned special exposures shall not be considered in controlling future occupational dose of the individual under WAC 246-221-010(1) but shall be included in evaluations required by subsections (4) and (5) of this section.

(8) The licensee or registrant submits a written report in accordance with WAC 246-221-265.

[Statutory Authority: RCW 70.98.050. WSR 01-05-110, § 246-221-030, filed 2/21/01, effective 3/24/01; WSR 94-01-073, § 246-221-030, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-030, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-030, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-027, filed 12/8/80.]

WAC 246-221-040 Determination of internal exposure of individuals to concentrations of radioactive materials in restricted areas. (1)

For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee shall, when required under WAC 246-221-100, take suitable and timely measurements of:

(a) Concentrations of radioactive materials in air in work areas;

or

(b) Quantities of radionuclides in the body; or

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

(d) Combinations of these measurements.

(2) Unless respiratory protective equipment is used, as provided in WAC 246-221-117, 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.

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

(a) 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

(b) Upon prior approval of the department, 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

(c) 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 WAC 246-221-290.

(4) If the licensee chooses to assess intakes of Class Y material using the measurements given in subsection (1)(b) or (c) of this section, the licensee may delay the recording and reporting of the assessments for periods up to seven months, unless otherwise required by WAC 246-221-250 or 246-221-260. This delay permits the licensee to make additional measurements basic to the assessments.

(5) 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:

(a) The sum of the ratios of the concentration to the appropriate DAC value, that is, D, W, or Y, from WAC 246-221-290 for each radionuclide in the mixture; or

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

(6) 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.

(7) When a mixture of radionuclides in air exists, a licensee may disregard certain radionuclides in the mixture if:

(a) The licensee uses the total activity of the mixture in demonstrating compliance with the dose limits in WAC 246-221-010 and in complying with the monitoring requirements in WAC 246-221-100; and

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

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

(8) When determining the committed effective dose equivalent, the following information may be considered:

(a) 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.

(b) For an ALI and the associated DAC determined by the non-stochastic organ dose limit of 0.50 Sv (50 rem), the intake of radionuclides that would result in a committed effective dose equivalent of 0.05 Sv (5 rem), that is, the stochastic ALI, is listed in parentheses in Table I of WAC 246-221-290. The licensee may, as a simplifying assumption, use the stochastic ALIs to determine committed effective dose equivalent. However, if the licensee uses the stochastic ALIs, the licensee shall also demonstrate that the limit in WAC 246-221-010 (1)(a)(ii) is met.

[Statutory Authority: RCW 70.98.050. WSR 14-01-077, § 246-221-040, filed 12/16/13, effective 1/16/14; WSR 94-01-073, § 246-221-040, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-040, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-040, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-030, filed 12/8/80; Order 1095, § 402-24-030, filed 2/6/76; Order 1, § 402-24-030, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-050 Occupational dose limits for minors. No licensee or registrant shall possess, use, or transfer sources of radiation in such a manner as to cause any occupationally exposed individual who is under 18 years of age, to receive a dose in excess of 10 percent of the annual occupational dose limits specified in WAC 246-221-010(1).

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-050, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-050, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-050, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-035, filed 12/8/80; Order 1095, § 402-24-035, filed 2/6/76.]

WAC 246-221-055 Dose equivalent to an embryo/fetus. (1) The licensee or registrant shall ensure that the dose equivalent to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 5 mSv (0.5 rem).

(2) Once pregnancy has been declared, the licensee or registrant shall make every effort to avoid substantial variation above a uniform

monthly exposure rate to a declared pregnant woman in order to satisfy the limit in subsection (1) of this section.

(3) If by the time the woman declares pregnancy to the licensee or registrant, the dose equivalent to the embryo/fetus has exceeded 4.5 mSv (0.45 rem), the licensee or registrant shall be deemed to be in compliance with subsection (1) of this section if the additional dose equivalent to the embryo/fetus does not exceed 0.50 mSv (0.05 rem) during the remainder of the pregnancy.

(4) The dose equivalent to an embryo/fetus shall be taken as the sum of:

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

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

(5) The licensee or registrant shall maintain the records of dose equivalent to an embryo/fetus with the records of dose equivalent 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.

[Statutory Authority: RCW 70.98.050. WSR 01-05-110, § 246-221-055, filed 2/21/01, effective 3/24/01; WSR 94-01-073, § 246-221-055, filed 12/9/93, effective 1/9/94.]

WAC 246-221-060 Dose limits for individual members of the public.

(1) Each licensee or registrant shall conduct operations so that:

(a) The total effective dose equivalent to individual members of the public from the licensed or registered operation does not exceed 1 mSv (0.1 rem) in a year, exclusive of the dose contributions from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released under chapter 246-240 WAC, from voluntary participation in medical research programs, and from the licensee's or registrant's disposal of radioactive material into sanitary sewerage in accordance with WAC 246-221-190; and

(b) The dose in any unrestricted area from external sources, exclusive of the dose contributions from patients administered radioactive material and released under chapter 246-240 WAC, does not exceed 0.02 mSv (0.002 rem) in any one hour.

(2) If the licensee or registrant permits members of the public to have access to restricted areas, they shall be escorted and the limits for members of the public continue to apply to those individuals.

(3) Notwithstanding subsection (1) of this section, a licensee or registrant may continue to operate a facility constructed and put into

operation prior to January 1, 1994, where the annual dose limit for an individual member of the public is more than 1 mSv (0.1 rem) and less than 5 mSv (0.5 rem) total effective dose equivalent, if:

(a) The facility's approved operating conditions for each radiation source remain the same. Any increase in the following operating conditions shall require reevaluation by the department and modification of the facility shielding applicable to the source of radiation to meet the 1 mSv (0.1 rem) total effective dose equivalent limit for individual members of the public: Size of the radiation source, workload, or occupancy factors associated with the source of radiation; and

(b) Any change in the permanent shielding of the facility due to remodeling, repair or replacement requires the facility to meet the 1 mSv (0.1 rem) total effective dose equivalent limit for individual members of the public for areas affected by that portion of the shielding.

(4) Each licensee or registrant shall maintain records sufficient to demonstrate compliance with the dose limit for individual members of the public.

[Statutory Authority: RCW 70.98.050. WSR 14-01-077, § 246-221-060, filed 12/16/13, effective 1/16/14; WSR 06-05-019, § 246-221-060, filed

2/6/06, effective 3/9/06; WSR 98-13-037, § 246-221-060, filed 6/8/98, effective 7/9/98; WSR 94-01-073, § 246-221-060, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-060, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-060, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-040, filed 12/11/86. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-040, filed 12/8/80; Order 1095, § 402-24-040, filed 2/6/76; Order 1, § 402-24-040, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-070 Compliance with dose limits for individual members of the public. (1) The licensee shall make or cause to be made surveys of radiation levels in unrestricted areas and radioactive materials in effluents released to unrestricted areas to demonstrate compliance with the dose limits for individual members of the public in WAC 246-221-060.

(2) A licensee shall show compliance with the annual dose limit in WAC 246-221-060 by:

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

(b) Demonstrating that:

(i) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in Table II of WAC 246-221-290; and

(ii) If an individual were continually present in an unrestricted area, the dose from external sources would not exceed 0.02 mSv (0.002 rem) in an hour and 0.50 mSv (0.05 rem) in a year.

(3) Upon approval from the department, the licensee may adjust the effluent concentration values in WAC 246-221-290, Table II, for members of the public, to take into account the actual physical and chemical characteristics of the effluents, such as, aerosol size distribution, solubility, density, radioactive decay equilibrium, and chemical form.

(4) The provisions of this section do not apply to disposal of radioactive material into sanitary sewerage systems, which is governed by WAC 246-221-190.

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-070, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-070, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-070, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-050, filed 12/11/86; Order 1095, § 402-24-050, filed 2/6/76; Order 1, § 402-24-050, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-080 Leak tests. (1) Each sealed radioactive source possessed under the provisions of a specific license, other than hydrogen-3 (tritium), with a half-life greater than thirty days and in any form other than gas, shall be tested and results obtained for leakage or contamination prior to initial use and at six-month intervals or as specified by the license, except that each source designed for the purpose of emitting alpha particles shall be tested at intervals not to exceed three months. If at any other time there is reason to suspect that a sealed source might have been damaged, it shall be tested for leakage and results obtained before further use. In the absence of a certificate from a transferor indicating that a test for

leakage has been made within six months prior to the transfer (three months for a source designed to emit alpha particles), the sealed source shall not be put into use until tested and the results received.

(2) Leak tests shall be capable of detecting the presence of 185 Bq (0.005 microcurie) of removable contamination. The results of leak tests made pursuant to subsection (1) of this section shall be recorded in units of becquerel or microcuries and shall be maintained for inspection by the department. Any test conducted pursuant to subsection (1) of this section which reveals the presence of 185 Bq (0.005 microcurie) or more of removable contamination shall be considered evidence that the sealed source is leaking. The licensee shall immediately withdraw the source from use shall take action to prevent the spread of contamination and shall cause it to be decontaminated and repaired or to be disposed in accordance with WAC 246-232-080. If a sealed source shows evidence of leaking, a report shall be filed with the department within five days of the test, describing the equipment involved, the test results, and the corrective action taken.

(3) Test samples shall be taken from the sealed source or from the internal surfaces or the opening of the container in which the sealed source is stored or from surfaces of devices or equipment in

which the sealed source is permanently mounted. Tests for contamination and leakage may be made by wiping appropriate accessible surfaces on which one might expect contamination to accumulate and measuring these wipes for transferred contamination. Test samples shall also be taken from the interior surfaces of the container in which a sealed source of radium is stored.

(4) Leak tests are required for sealed radioactive sources that are greater than 3.7 MBq (100 microcuries) for beta and gamma emitting sources and greater than 370 KBq (10 microcuries) for sources designed to emit alpha particles.

(5) Tests for leakage or contamination shall be performed by persons specifically authorized by the department, an agreement state, or the NRC to perform such services.

[Statutory Authority: RCW 70.98.050. WSR 14-01-077, § 246-221-080, filed 12/16/13, effective 1/16/14; WSR 94-01-073, § 246-221-080, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-080, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-080, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-24-060, filed 9/16/83. Statutory Authority: RCW

70.98.050. WSR 81-01-011 (Order 1570), § 402-24-060, filed 12/8/80; Order 1095, § 402-24-060, filed 2/6/76; Order 1, § 402-24-060, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-090 Personnel monitoring for external dose. Each licensee or registrant shall monitor occupational exposure from sources of radiation at levels sufficient to demonstrate compliance with the occupational dose limits of WAC 246-221-010, 246-221-030, 246-221-050 and 246-221-055.

(1) Each licensee or registrant shall monitor occupational exposure to radiation from licensed (or registered) and unlicensed (or unregistered) radiation sources under the control of the licensee or registrant and shall supply and shall require the use of individual monitoring devices by:

(a) Each adult likely to receive, in one year from sources external to the body, a dose in excess of ten percent of the applicable limits specified in WAC 246-221-010(1).

(b) Each minor likely to receive, in one year from sources external to the body, a deep dose equivalent in excess of 1 mSv (0.1 rem), a lens dose equivalent in excess of 1.5 mSv (0.15 rem), or a shallow

dose equivalent to the skin or to the extremities in excess of 5 mSv (0.5 rem).

(c) Each declared pregnant woman likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent in excess of 1 mSv (0.1 rem). All of the occupational dose limits specified in WAC 246-221-010 continue to be applicable to the declared pregnant worker as long as the embryo/fetus dose limit is not exceeded.

(d) Each individual who enters a high or very high radiation area.

(2) Personnel monitoring devices assigned to an individual:

(a) Shall not intentionally be exposed to give a false or erroneous reading;

(b) Shall be assigned to one individual per exposure interval (i.e., weekly, monthly) and used to determine exposure for that individual only;

(c) Shall not be worn by any individual other than that individual originally assigned to the device;

(d) Personnel monitoring devices that are exposed while not being worn by the assigned individual shall be processed and recorded as soon as possible. A replacement monitoring device shall be assigned to

the individual immediately. A record of the circumstances of the exposure shall be retained.

(3) All personnel dosimeters, except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to any extremities, that require processing to determine the radiation dose and that are utilized by licensees or registrants to comply with subsection (1) of this section, with other applicable provisions of chapters 246-220 through 246-255 WAC, or with conditions specified in a licensee's license must be processed and evaluated by a dosimetry processor:

(a) Holding current personnel dosimetry accreditation from either the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (formerly known as the National Bureau of Standards) or the United States Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems (DOELAP); and

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

(4) For the purposes of this section "dosimetry processor" means an individual or an organization that processes and evaluates personnel monitoring devices in order to determine the radiation dose delivered to the device.

(5) Each licensee or registrant shall maintain records of doses received by all individuals for whom monitoring was required under subsection (1) of this section, 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 January 1, 1994, need not be changed. These records shall include, when applicable:

(a) The deep dose equivalent to the whole body, lens dose equivalent, shallow dose equivalent to the skin, and shallow dose equivalent to the extremities; and

(b) The total effective dose equivalent when required by WAC 246-221-015; and

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

(6) The licensee or registrant shall maintain the records specified in subsection (5) of this section on department Form RHF-5A, in

accordance with the instructions provided on the form, or in clear and legible records containing all the information required by Form RHF-5A; and shall update the information at least annually.

(7) Each licensee or registrant shall ensure that individuals, for whom they are required to monitor occupational doses in accordance with subsection (1) of this section, wear individual monitoring devices as follows:

(a) An individual monitoring device used for monitoring the dose to the whole body shall be worn at the unshielded or least shielded location of the whole body likely to receive the highest exposure. When a protective apron is worn, the location of the individual monitoring device is typically at the neck (collar).

(b) Any additional individual monitoring device used for monitoring the dose to an embryo/fetus of a declared pregnant woman, pursuant to WAC 246-221-055(1), shall be located at the waist under any protective apron being worn by the woman.

(c) An individual monitoring device used for monitoring the lens dose equivalent, to demonstrate compliance with WAC 246-221-010 (1)(b)(i), shall be located at the neck (collar), outside any protective apron being worn by the monitored individual, or at an unshielded location closer to the eye.

(d) An individual monitoring device used for monitoring the dose to the extremities, to demonstrate compliance with WAC 246-221-010 (1)(b)(ii), shall be worn on the extremity likely to receive the highest exposure. Each individual monitoring device shall be oriented to measure the highest dose to the extremity being monitored.

[Statutory Authority: RCW 70.98.050. WSR 01-05-110, § 246-221-090, filed 2/21/01, effective 3/24/01; WSR 94-01-073, § 246-221-090, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 92-06-008 (Order 245), § 246-221-090, filed 2/21/92, effective 3/23/92. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-090, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-070, filed 12/8/80; Order 1095, § 402-24-070, filed 2/6/76; Order 708, § 402-24-070, filed 8/24/72; Order 1, § 402-24-070, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-100 Personnel monitoring for internal dose. (1) Each licensee shall monitor, to determine compliance with WAC 246-221-040, the occupational intake of radioactive material by and assess the committed effective dose equivalent to:

(a) Adults likely to receive, in 1 year, an intake in excess of ten percent of the applicable ALI in Table I, Columns 1 and 2, of WAC 246-221-290;

(b) Minors likely to receive, in one year, a committed effective dose equivalent in excess of 1 mSv (0.1 rem); and

(c) Declared pregnant women likely to receive, during the entire pregnancy, a committed effective dose equivalent in excess of 1 mSv (0.1 rem).

(2) Where necessary or desirable in order to aid in determining the extent of an individual's exposure to concentrations of radioactive material, the department may incorporate license provisions or issue an order requiring a licensee or registrant to make available to the individual appropriate bioassay services and to furnish a copy of the reports of such services to the department.

(3) Each licensee shall maintain records of doses received by all individuals for whom monitoring was required pursuant to subsections (1) and (2) of this section, 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 January 1, 1994, need not be changed. These records shall include, when applicable:

(a) The estimated intake or body burden of radionuclides;

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

(c) The specific information used to calculate the committed effective dose equivalent pursuant to WAC 246-221-040;

(d) The total effective dose equivalent when required by WAC 246-221-015; and

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

(4) The licensee or registrant shall maintain the records specified in subsection (3) of this section on department Form RHF-5A, in accordance with the instructions provided on the form, or in clear and legible records containing all the information required by Form RHF-5A; and shall update the information at least annually.

[Statutory Authority: RCW 70.98.050. WSR 01-05-110, § 246-221-100, filed 2/21/01, effective 3/24/01; WSR 94-01-073, § 246-221-100, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-100, filed 12/27/90, effective 1/31/91; Order 1095, § 402-24-080, filed 2/6/76; Order 1, § 402-24-080, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-102 Control of access to high radiation areas. (1)

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:

(a) 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 one hour at thirty centimeters from the source of radiation or from any surface that the radiation penetrates; or

(b) 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

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

(2) In place of the controls required by subsection (1) of this section for a high radiation area, the licensee or registrant may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry.

(3) The licensee or registrant may apply to the department for approval of alternative methods for controlling access to high radiation areas.

(4) The licensee or registrant shall establish the controls required by subsections (1) and (3) of this section in a way that does not prevent individuals from leaving a high radiation area.

(5) The licensee 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 United States Department of Transportation provided that:

(a) The packages do not remain in the area longer than three days; and

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

(6) 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 and to operate within the ALARA provisions of the licensee's radiation protection program.

(7) The licensee or registrant is not required to control entrance or access to rooms or other areas as described in this section if the licensee or registrant has met all the specific requirements for access and control specified in other applicable chapters of these regulations, such as, chapter 246-243 WAC for industrial radiography, chapter 246-225 WAC for X rays in the healing arts, and chapter 246-229 WAC for particle accelerators.

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-102, filed 12/9/93, effective 1/9/94.]

WAC 246-221-104 Control of access to very high radiation areas.

(1) In addition to the requirements in WAC 246-221-102, the licensee or registrant shall institute additional measures to ensure that an individual is not able to gain unauthorized or inadvertent access to areas in which radiation levels could be encountered at five Gy (500 rad) or more in one hour at one meter from a source of radiation or any surface through which the radiation penetrates. This requirement does not apply to rooms or areas in which diagnostic X-ray systems are the only source of radiation, or to nonself-shielded irradiators.

(2) The licensee or 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 this section if the licensee or registrant has met all the specific requirements for access and control specified in other applicable chapters of these regulations, such as, chapter 246-243 WAC for industrial radiography, chapter 246-225 WAC for X rays in the healing arts, and chapter 246-229 WAC for particle accelerators.

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-104, filed 12/9/93, effective 1/9/94.]

**WAC 246-221-106 Control of access to very high radiation areas—
Irradiators.** (1) This section applies to licensees or registrants with sources of radiation in nonself-shielded irradiators. This section 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 a radiation level of five Gy (500 rad) or

more in one hour at one meter in an area that is accessible to any individual.

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

(a) Each entrance or access point shall be equipped with entry control devices which:

(i) Function automatically to prevent any individual from inadvertently entering a very high radiation area; and

(ii) 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 one mSv (0.1 rem) in one hour; and

(iii) 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 one mSv (0.1 rem) in one hour.

(b) Additional control devices shall be provided so that, upon failure of the entry control devices to function as required by (a) of this subsection:

(i) 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 one mSv (0.1 rem) in one hour; and

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

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

(i) 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 one mSv (0.1 rem) in one hour; and

(ii) Conspicuous visible and audible alarm signals are generated to make potentially affected individuals aware of the hazard and the licensee or registrant or at least one other individual, who is famil-

iar with the activity and prepared to render or summon assistance, aware of the failure or removal of the physical barrier.

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

(e) 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 (c) and (d) of this subsection.

(f) 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.

(g) 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.

(h) 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 one mSv (0.1 rem) in one hour.

(i) 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. Exit portals for irradiated materials shall be equipped to detect and signal the presence of any loose radioactive material that is carried toward such an exit and automatically to prevent loose radioactive material from being carried out of the area.

(3) The entry control devices required in subsection (2)(a) of this section shall be tested for proper functioning:

(a) Prior to initial operation with the source of radiation on any day, unless operations were continued uninterrupted from the previous day; and

(b) Prior to resumption of operation of the source of radiation after any unintentional interruption; and

(c) In accordance with a schedule for periodic tests of the entry control and warning systems submitted by the licensee or registrant and approved by the department.

(4) The licensee or 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.

(5) Licensees, registrants, or applicants for licenses or registrations for sources of radiation within the purview of subsection (2) of this section which will be used in a variety of positions or in locations, such as open fields or forests, that make it impracticable to comply with certain requirements of subsection (2) of this section, such as those for the automatic control of radiation levels, may apply to the department for approval of alternative safety measures. Alternative safety measures shall provide personnel protection at least equivalent to those specified in subsection (2) of this section. 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.

(6) The entry control devices required by subsections (2) and (3) of this section shall be established in such a way that no individual will be prevented from leaving the area.

(7) The licensee shall maintain records of tests made pursuant to subsection (3) of this section on entry control devices for very high radiation areas. These records shall include the date, time, and results of each such test of function.

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-106, filed 12/9/93, effective 1/9/94.]

WAC 246-221-110 Surveys. (1) Each licensee or registrant shall make or cause to be made such surveys, as defined in WAC 246-220-010, as may be necessary for the licensee or registrant to establish compliance with these regulations and are reasonable under the circumstances to evaluate the magnitude and extent of radiation levels, concentrations or quantities of radioactive material, and potential radiation hazards. Records of such surveys shall be preserved as specified in WAC 246-221-230. Information on performing surveys may be found in the NRC's Regulatory Guide 8.23 "Radiation Safety Surveys at Medical Institutions."

(2) The licensee shall ensure that instruments and equipment used for quantitative radiation measurements, for example, dose rate and effluent monitoring, are calibrated annually at intervals not to exceed thirteen months for the radiation measured.

[Statutory Authority: RCW 70.98.050. WSR 14-01-077, § 246-221-110, filed 12/16/13, effective 1/16/14; WSR 01-05-110, § 246-221-110, filed 2/21/01, effective 3/24/01; WSR 94-01-073, § 246-221-110, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-110, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-110, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-085, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-24-085, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-085, filed 12/8/80; Order 1095, § 402-24-085, filed 2/6/76.]

WAC 246-221-113 Use of process, engineering or other controls.

(1) The licensee shall use, to the extent practical, process or other engineering controls, such as, containment, decontamination, or ventilation, to control the concentrations of radioactive material in air.

(2) 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 shall, consistent with maintaining the total effective dose equivalent ALARA, increase monitoring and limit intakes by one or more of the following means:

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

(3) If the licensee performs an ALARA analysis to determine whether or not respirators should be used, the licensee may consider safety factors other than radiological factors. The licensee should also consider the impact of respirator use on workers' industrial health and safety.

[Statutory Authority: RCW 70.98.050. WSR 01-05-110, § 246-221-113, filed 2/21/01, effective 3/24/01; WSR 94-01-073, § 246-221-113, filed 12/9/93, effective 1/9/94.]

WAC 246-221-117 Use of individual respiratory protection equipment. If the licensee assigns or permits the use of respiratory protection equipment to limit the intake of radioactive material:

(1) The licensee shall use only respiratory protection equipment that is:

(a) Tested and certified by the National Institute for Occupational Safety and Health (NIOSH); or

(b) Approved by the department on the basis of the licensee's submittal of an application for authorized use of other respiratory protection 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.

(2) The licensee shall implement and maintain a respiratory protection program that includes:

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

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

(c) Testing of respirators for operability (user seal check for face sealing devices and functional check for others) immediately prior to each use;

(d) Written procedures regarding:

(i) Monitoring, including air sampling and bioassays;

(ii) Supervision and training of respirator users;

(iii) Fit testing;

(iv) Respirator selection;

(v) Breathing air quality;

(vi) Inventory and control;

(vii) Storage, issuance, maintenance, repair, testing, and quality assurance of respiratory protection equipment;

(viii) Recordkeeping; and

(ix) Limitations on periods of respirator use and relief from respirator use;

(e) Determination by a physician that the individual user is medically fit to use respiratory protection equipment:

(i) Before the initial fitting of a face sealing respirator;

(ii) Before the first field use of nonface sealing respirators;

and

(iii) Either every twelve months thereafter, or periodically at a frequency determined by a physician; and

(f) Fit testing, with a fit factor greater than or equal to ten times the APF for negative pressure devices, and a fit factor greater than or equal to five hundred for any positive pressure, continuous flow, and pressure-demand devices, before the first field use of tight fitting, face sealing respirators, and periodically thereafter at a frequency not to exceed one year. Fit testing must be performed with the facepiece operating in the negative pressure mode.

(3) 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 relief.

(4) The licensee shall also consider limitations appropriate to the type and mode of use. When selecting respiratory devices the licensee shall provide for vision correction, adequate communication, low temperature work environments, and the concurrent use of other safety or radiological protection equipment. The licensee shall use equipment in such a way as not to interfere with the proper operation of the respirator.

(5) Standby rescue persons are required whenever one-piece atmosphere-supplying suits, or any combination of supplied air respiratory protection device and personnel protective equipment are used from which an unaided individual would have difficulty extricating himself or herself. The standby persons must be equipped with respiratory protection devices or other apparatus appropriate for the potential hazards. The standby rescue persons shall observe or otherwise maintain continuous communication with the workers (visual, voice, signal line, telephone, radio, or other suitable means), and be immediately available to assist them in case of a failure of the air supply or for any other reason that requires relief from distress. A sufficient number of standby rescue persons must be immediately available to assist all users of this type of equipment and to provide effective emergency rescue if needed.

(6) Atmosphere-supplying respirators must be supplied with respirable air of grade D quality or better as defined by the Compressed Gas Association in publication G-7.1, "*Commodity Specification for Air*," 1997 and included in the regulations of the Occupational Safety and Health Administration (29 C.F.R. 1910.134 (i)(1)(ii)(A) through (E)). Grade D quality air criteria include:

(a) Oxygen content (v/v) of 19.5-23.5%;

(b) Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;

(c) Carbon monoxide (CO) content of 10 ppm or less;

(d) Carbon dioxide content of 1,000 ppm or less; and

(e) Lack of noticeable odor.

(7) The licensee shall ensure that no objects, materials or substances, such as facial hair, or any conditions that interfere with the face-to-facepiece seal or valve function, and that are under the control of the respirator wearer, are present between the skin of the wearer's face and the sealing surface of a tight-fitting respirator facepiece.

(8) In estimating the dose to individuals from intake of airborne radioactive materials, the concentration of radioactive material in the air that is inhaled when respirators are worn is initially assumed to be the ambient concentration in air without respiratory protection, divided by the assigned protection factor. If the dose is later found to be greater than the estimated dose, the corrected value must be used. If the dose is later found to be less than the estimated dose, the corrected value may be used.

(9) The department may impose restrictions in addition to the provisions of this section, WAC 246-221-113 and 246-221-285, in order to:

(a) Ensure that the respiratory protection program of the licensee is adequate to limit doses to individuals from intakes of airborne radioactive materials consistent with maintaining total effective dose equivalent ALARA; and

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

(10) The licensee shall obtain authorization from the department before using assigned protection factors in excess of those specified in WAC 246-221-285. The department may authorize a licensee to use higher assigned protection factors on receipt of an application that:

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

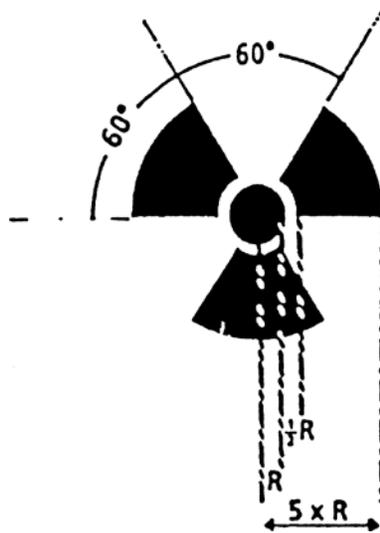
(b) Demonstrates that the respiratory protection equipment provides these higher protection factors under the proposed conditions of use.

[Statutory Authority: RCW 70.98.050. WSR 01-05-110, § 246-221-117, filed 2/21/01, effective 3/24/01; WSR 98-13-034, § 246-221-117, filed

6/8/98, effective 7/9/98; WSR 94-01-073, § 246-221-117, filed 12/9/93, effective 1/9/94.]

WAC 246-221-120 Caution signs, and labels. (1) The radiation symbol shall be used on all signs, labels, or other written means of warning individuals concerning radiation hazards.

(a) The symbol prescribed by this section is the conventional three-blade design: Radiation symbol



(b) The symbol prescribed by this section shall be:

(i) Magenta, purple, or black on a yellow background; or

(ii) Conspicuously etched or stamped without regard to a color requirement on sources, source holders or device components containing sources which are subjected to extreme environmental conditions which would cause the color to deteriorate.

(2) The conventional radiation symbol as described in subsection (1) of this section shall be used only for:

(a) Instructing individuals to be cognizant of a potential radiation hazard as prescribed in subsections (4) through (10) of this section.

(b) Indicating that information presented pertains to the topic of radiation.

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

(4) Each *radiation area* and entrance thereto shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words: CAUTION* - RADIATION AREA. However, in an exceptionally large room where other activities of a nonradiological nature are conducted the entrance need not be posted provided a conspicuous barricade with an appropriate number of signs is established to delineate the radiation area.

(5) Each high radiation area and all entrances thereto shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words: CAUTION* - HIGH RADIATION AREA OR DANGER - HIGH RADIA-

TION AREA. To avoid unnecessary exposure, the licensee or registrant may satisfy this requirement by posting the sign at the estimated location or vicinity of the high radiation area.

(6) Each very high radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words: GRAVE DANGER - VERY HIGH RADIATION AREA. To avoid unnecessary exposure, the licensee or registrant may satisfy this requirement by posting the sign at the estimated location or vicinity of the very high radiation area.

(7) Each airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words: CAUTION* - AIRBORNE RADIOACTIVITY AREA OR DANGER - AIRBORNE RADIOACTIVITY AREA.

(8) Each area or room in which any radioactive material is used or stored in an amount exceeding 10 times the quantity of radioactive material specified in WAC 246-221-300 shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words: CAUTION* - RADIOACTIVE MATERIAL OR DANGER - RADIOACTIVE MATERIAL.

(9) Each container of radioactive material shall bear a durable, clearly visible label identifying the radioactive contents including:

(a) The radiation caution symbol and the words: CAUTION* - RADIOACTIVE MATERIAL OR DANGER - RADIOACTIVE MATERIAL.

(b) Sufficient information to permit individuals handling or using the containers, or working in the vicinity thereof, to take precautions to avoid or minimize exposures, such as radionuclides present, radiation levels, estimate of activity and mass enrichment.

(c) Where containers are used for storage, the quantities and kinds of radioactive materials in the containers and the date of measurement of the quantities.

(10) All radiation machines shall be labeled in a conspicuous manner so as to caution individuals that radiation is produced when the machine is being operated.

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-120, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-120, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-120, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-090, filed 12/11/86. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-090, filed 12/8/80; Order 1095, § 402-24-090, filed 2/6/76; Order 1, § 402-24-090, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-130 Exceptions from posting and labeling require-

ments. (1) 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 30 centimeters from the surface of the source container or housing does not exceed 0.05 mSv (five millirem) per hour.

(2) Rooms or other areas in hospitals that are occupied by patients are not required to be posted with caution signs because of the presence of patients containing radioactive material if the patient could be released from licensee control under chapter 246-240 WAC.

(3) Caution signs are not required to be posted in areas or rooms containing radioactive material for periods of less than eight hours if:

(a) The material is constantly attended during those periods by an individual who takes precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established in these rules; and

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

(4) A room or other area is not required to be posted with a caution sign because of the presence of radioactive material prepared for

transport and packaged and labeled in accordance with regulations of the United States Department of Transportation.

(5) A room or area is not required to be posted with a caution sign because of the presence of a diagnostic X-ray system used solely for healing arts purposes.

(6) The interior of a teletherapy room is not required to be posted with caution signs provided the posting is conspicuously placed at the entrance(s) to the rooms.

(7) A licensee is not required to label:

(a) Containers holding licensed material in quantities less than the quantities listed in WAC 246-221-300; or

(b) Containers holding licensed material in concentrations less than those specified in WAC 246-221-290, Table III; or

(c) Containers attended by an individual who takes the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established by this chapter; or

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

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

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

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

[Statutory Authority: RCW 70.98.050. WSR 06-05-019, § 246-221-130, filed 2/6/06, effective 3/9/06; WSR 98-13-037, § 246-221-130, filed 6/8/98, effective 7/9/98; WSR 94-01-073, § 246-221-130, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-130, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-130, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-

24-095, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-095, filed 12/8/80; Order 1095, § 402-24-095, filed 2/6/76.]

WAC 246-221-140 Instruction of personnel. Instructions required for individuals working in or frequenting any portion of a restricted area are specified in WAC 246-222-020, 246-222-030, and 246-222-040.

[Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-140, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-140, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-24-110, filed 9/16/83; Order 1095, § 402-24-110, filed 2/6/76; Order 708, § 402-24-110, filed 8/24/72; Order 1, § 402-24-110, filed 7/2/71; Order 1, § 402-24-110, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-150 Security and control of radioactive material and radiation machines. (1) Licensed radioactive materials and registered radiation machines shall be secured from, or controlled in such a manner so as to prevent, unauthorized access or removal from the place of storage.

(2) Each portable gauge licensee shall use a minimum of two independent physical controls that form tangible barriers to secure portable gauges from unauthorized removal, whenever portable gauges are not under the control and constant surveillance of the licensee.

(3) Licensed radioactive materials in an unrestricted area and not in storage shall be tended under the constant surveillance and immediate control of the licensee.

(4) Registered radiation machines in an unrestricted area and not in storage shall be under the control of the registrant.

[Statutory Authority: RCW 70.98.050. WSR 07-17-028, § 246-221-150, filed 8/7/07, effective 9/7/07; WSR 94-01-073, § 246-221-150, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-150, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-24-120, filed 9/16/83; Order 1095, § 402-24-120, filed 2/6/76; Order 1, § 402-24-120, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-160 Procedures for picking up, receiving, and opening packages. (1) Each licensee who expects to receive a package containing quantities of radioactive material in excess of the Type A₁ or A₂

quantities specified in WAC 246-231-200 shall make arrangements to receive:

(a) The package when it is offered for delivery by the carrier;

or

(b) Immediate notification from the carrier of the arrival of the package at the carrier's terminal.

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

(3) Each licensee shall:

(a) Monitor for radioactive contamination the external surfaces of any package labeled with a Radioactive White I, Yellow II or Yellow III label unless the package contains only radioactive material in the form of gas or in special form as defined in WAC 246-231-010; and

(b) Monitor the radiation levels of the external surfaces of any package labeled with a Radioactive White I, Yellow II or Yellow III label unless the package contains quantities of radioactive material that are less than or equal to the Type A quantity, as defined in WAC 246-231-200; and

(c) Monitor all packages known to contain radioactive material for radioactive contamination and radiation levels if the package has

evidence of potential contamination, such as packages that are crushed, wet, or damaged.

(4) Monitoring shall be performed:

(a) Immediately upon receipt if there is evidence of package degradation or any other evidence of potential contamination or excessive radiation levels; or

(b) As soon as practicable after receipt, but no later than three hours after the package is received at the licensee's facility if received during the licensee's normal working hours, or no later than three hours from the beginning of the next working day if received after normal working hours.

(5) The licensee shall immediately notify the final delivery carrier and, by telephone, facsimile, email, or letter, the department when:

(a) For normal shipments, removable radioactive surface contamination exceeds either 22 dpm/cm² for beta-gamma emitting radionuclides, all radionuclides with half-lives less than ten days, natural uranium, natural thorium, uranium-235, uranium-238, thorium-232, and thorium-228 and thorium 230 when contained in ores or concentrates; or 2.2 dpm/cm² for all other alpha emitting radionuclides; or

(b) For exclusive use shipments, removable radioactive surface contamination exceeds either 220 dpm/cm² for beta-gamma emitting radionuclides, all radionuclides with half-lives less than ten days, natural uranium, natural thorium, uranium-235, uranium-238, thorium-232, and thorium-228 and thorium 230 when contained in ores or concentrates; or 22 dpm/cm² for all other alpha emitting radionuclides; or

(c) For normal or exclusive use shipments, external radiation levels exceed two mSv/hour (200 millirem per hour) at any point on the external surface of the package; or

(d) For exclusive use shipments where the shipment is made in a closed transport vehicle, packages are secured in a fixed position, and no loading or unloading occurs between the beginning and end of transportation, external radiation levels exceed ten mSv/hour (1000 millirem per hour) at any point on the external surface of the package.

(6) Each licensee shall establish and maintain procedures for safely opening packages in which radioactive material is received, and shall assure that such procedures are followed and that due consideration is given to instructions for the type of package being opened and the monitoring of potentially contaminated packaging material (including packages containing radioactive material in gaseous form) to as-

sure that only background levels of radiation are present prior to disposal of such material as nonradioactive waste.

(7) Licensees transferring special form sources to and from a work site in vehicles owned or operated by the licensee are exempt from the contamination monitoring requirements of subsection (3)(a) of this section but are not exempt from the monitoring requirement in subsection (3)(b) of this section for measuring radiation levels to ensure that the source is still properly lodged in its shield.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-221-160, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 14-01-077, § 246-221-160, filed 12/16/13, effective 1/16/14; WSR 99-15-105, § 246-221-160, filed 7/21/99, effective 8/21/99; WSR 94-01-073, § 246-221-160, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-160, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-160, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-125, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-24-125, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order

1570), § 402-24-125, filed 12/8/80; Order 1095, § 402-24-125, filed 2/6/76.]

WAC 246-221-170 Waste disposal, general requirement. (1) No licensee shall dispose of any radioactive material except:

(a) By transfer to an authorized recipient as provided in WAC 246-232-080, or chapter 246-249 WAC; or

(b) As authorized pursuant to WAC 246-221-070, 246-221-180, 246-221-190, 246-221-200, 246-221-210, or 246-221-220.

(c) By decay in storage as authorized in a specific license.

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

(a) Treatment prior to disposal; or

(b) Treatment or disposal by incineration; or

(c) Decay in storage; or

(d) Disposal at a land disposal facility licensed pursuant to chapter 246-250 WAC; or

(e) Storage until transferred to a disposal facility authorized to receive the waste.

(3) Nothing in chapter 246-221 WAC 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 pursuant to this chapter.

(4) Each licensee shall maintain records of all transfers and disposals of radioactive material. Requirements for the disposition of certain disposal records, prior to license termination, are located in WAC 246-232-060.

[Statutory Authority: RCW 70.98.050. WSR 99-15-105, § 246-221-170, filed 7/21/99, effective 8/21/99; WSR 94-01-073, § 246-221-170, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-170, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-170, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-130, filed 12/8/80; Order 1095, § 402-24-130, filed 2/6/76; Order 1, § 402-24-130, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-180 Method of obtaining approval of proposed disposal procedures. Any person may apply to the department for approval of proposed procedures to dispose of radioactive material in a manner not otherwise authorized in this chapter. Each application shall contain a

description of the radioactive material, including the quantities and kinds of radioactive material and levels of radioactivity involved, the physical and chemical properties that have an impact on risk evaluation, and the proposed manner and conditions of disposal. The application, where appropriate, shall also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics; usage of ground and surface waters in the general area; the nature and location of other potentially affected facilities; analyses and procedures to ensure that doses are maintained ALARA within the dose limits of this chapter; and procedures to be observed to minimize the risk of unexpected or hazardous exposures.

The department will not approve any application for a license to receive radioactive material from other persons for disposal on land not owned by a state or the federal government.

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-180, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-180, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-135, filed 12/11/86; Order 1095, § 402-24-135, filed 2/6/76.]

WAC 246-221-190 Disposal by release into sanitary sewerage sys-

tems. (1) No licensee shall discharge radioactive material into a sanitary sewerage system unless:

(a) It is readily soluble or it is biological material which is readily dispersible in water;

(b) The quantity of any radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee, will not result in an average concentration exceeding the limits specified in WAC 246-221-290, Table III; and

(c) The sum of the fractions for each radionuclide, if more than one radionuclide is released, will not exceed unity; where the fraction for each radionuclide is determined by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the concentration of that radionuclide listed in Table III of WAC 246-221-290; and

(d) The total quantity of licensed and other 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.

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

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-190, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-190, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-190, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-24-140, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-140, filed 12/8/80; Order 1095, § 402-24-140, filed 2/6/76; Order 1, § 402-24-140, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-200 Disposal by burial in soil. No licensee shall dispose of radioactive material by burial in soil except as specifically approved by the department pursuant to WAC 246-221-180.

[Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-200, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-200, filed 12/27/90, effective 1/31/91. Statutory Authority:

RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-150, filed 12/8/80; Order 1095, § 402-24-150, filed 2/6/76; Order 1, § 402-24-150, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-210 Disposal by incineration. No licensee shall incinerate radioactive material for the purpose of disposal or preparation for disposal except as specifically approved by the department pursuant to WAC 246-221-070 and 246-221-180.

[Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-210, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-210, filed 12/27/90, effective 1/31/91; Order 1095, § 402-24-160, filed 2/6/76; Order 1, § 402-24-160, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-220 Disposal of specific wastes. (1) Any licensee may dispose of the following licensed material without regard to its radioactivity:

(a) 1.85 KBq (0.05 microcurie) or less of hydrogen-3 or carbon-14, per gram of medium, used for liquid scintillation counting; and

(b) 1.85 KBq (0.05 microcurie) or less of hydrogen-3 or carbon-14, per gram of animal tissue averaged over the weight of the entire animal.

(2) The licensee shall not dispose of tissue under this section in a manner that would permit its use either as food for humans or as animal feed; and

(3) Nothing in this section, however, relieves the licensee of maintaining records showing the receipt, transfer and disposal of such radioactive material as specified in WAC 246-220-020; and

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

[Statutory Authority: RCW 70.98.050. WSR 14-01-077, § 246-221-220, filed 12/16/13, effective 1/16/14; WSR 94-01-073, § 246-221-220, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-220, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-220, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-24-165, filed 9/16/83.]

WAC 246-221-230 Records important to radiation safety. (1) Each

licensee or registrant shall make and retain records of activities, program reviews, measurements, and calculations which may be necessary to determine the extent of occupational and public exposure from sources of radiation under the control of the licensee or registrant.

(2) Each record required by this section shall be legible throughout the specified retention period.

(3) 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 these regulations.

(4) The licensee or registrant shall make a clear distinction among the quantities entered on the records required by these regulations such as, total effective dose equivalent, total organ dose equivalent, shallow dose equivalent, lens dose equivalent, deep dose equivalent, or committed effective dose equivalent.

(5) Records which must be maintained under this part shall be the original or a reproduced copy or microform if such reproduced copy or microform is duly authenticated by authorized personnel and the microform is capable of producing a clear and legible copy after storage

for the period specified by department regulations. The record may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period. Electronic media data storage systems shall incorporate standard or universally recognized security measures. Records, such as letters, drawings, and specifications, shall include all pertinent information, such as stamps, initials, and signatures.

(6) The licensee shall maintain adequate safeguards against tampering with and loss of records.

(7) The licensee or registrant shall retain the following required records until the department terminates each pertinent license or registration requiring the record, and upon termination of the license or registration, the licensee or registrant shall store for at least thirty years:

(a) Records of prior occupational dose and exposure history as recorded on department Form RHF-4 or RHF-4A, or equivalent;

(b) Records on department Form RHF-5 or RHF-5A, or equivalent, of doses received by all individuals for whom monitoring was required pursuant to WAC 246-221-090 and 246-221-100;

(c) Records of doses received during planned special exposures, accidents, and emergency conditions;

(d) The specific information used to calculate the committed effective dose equivalent pursuant to WAC 246-221-040(3);

(e) 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;

(f) Records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose;

(g) Records showing the results of air sampling, surveys, and bioassays required pursuant to WAC 246-221-117 (1)(b)(i) and (ii);

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

(8) The licensee or registrant shall retain the following records until the department terminates the pertinent license or registration requiring the record:

(a) Records of waste disposal made under the provisions of WAC 246-221-180, 246-221-190, 246-221-210 and 246-221-220, chapter 246-249 WAC, and any burials in soil as previously authorized;

(b) Records of dose to individual members of the public as required by WAC 246-221-060(4);

(c) Records of the provisions of the radiation protection program as required by WAC 246-221-005.

(9) The licensee or registrant shall retain the following records for three years after the record is made:

(a) Records of testing entry control devices for very high radiation areas as required by WAC 246-221-106(3);

(b) Records used in preparing department Form RHF-4 or RHF-4A;

(c) Records showing the results of general surveys required by WAC 246-221-110 and package surveys required by WAC 246-221-160;

(d) Records of calibrations required by WAC 246-221-110;

(e) Records of program audits and other reviews of the content and implementation of the radiation protection program required by WAC 246-221-005;

(f) Records of waste disposal by decay in storage.

(10) If there is a conflict between the department's regulations in this part, license condition, or other written department 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 department, under WAC 246-220-050, has granted a specific exemption from the record retention requirements specified in the regulations in this part.

(11) The discontinuance or curtailment of activities does not relieve the licensee or registrant of responsibility for retaining all records required by this section.

[Statutory Authority: RCW 70.98.050. WSR 01-05-110, § 246-221-230, filed 2/21/01, effective 3/24/01; WSR 94-01-073, § 246-221-230, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-230, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-230, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-170, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-24-170, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-170, filed 12/8/80; Order 1095, § 402-24-170, filed 2/6/76; Order 708, § 402-24-170, filed 8/24/72; Order 1, § 402-24-170, filed 7/2/71; Order 1, § 402-24-170, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-235 Reports of transactions involving nationally tracked sources. Each licensee who manufactures, transfers, receives, disassembles, or disposes of a nationally tracked source shall complete and submit a National Source Tracking Transaction Report as

specified in subsections (1) through (5) of this section for each type of transaction.

(1) Each licensee who manufactures a nationally tracked source shall complete and submit a National Source Tracking Transaction Report. The report must include the following information:

(a) The name, address, and license number of the reporting licensee;

(b) The name of the individual preparing the report;

(c) The manufacturer, model, and serial number of the source;

(d) The radioactive material in the source;

(e) The initial source strength in becquerels (curies) at the time of manufacture; and

(f) The manufacture date of the source.

(2) Each licensee that transfers a nationally tracked source to another person shall complete and submit a National Source Tracking Transaction Report. The report must include the following information:

(a) The name, address, and license number of the reporting licensee;

(b) The name of the individual preparing the report;

(c) The name and license number of the recipient facility and the shipping address;

(d) The manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;

(e) The radioactive material in the source;

(f) The initial or current source strength in becquerels (curies);

(g) The date for which the source strength is reported;

(h) The shipping date;

(i) The estimated arrival date; and

(j) For nationally tracked sources transferred as waste under a Uniform Low-Level Radioactive Waste Manifest, the waste manifest number and the container identification of the container with the nationally tracked source.

(3) Each licensee that receives a nationally tracked source shall complete and submit a National Source Tracking Transaction Report. The report must include the following information:

(a) The name, address, and license number of the reporting licensee;

(b) The name of the individual preparing the report;

(c) The name, address, and license number of the person that provided the source;

(d) The manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;

(e) The radioactive material in the source;

(f) The initial or current source strength in becquerels (curies);

(g) The date for which the source strength is reported;

(h) The date of receipt; and

(i) For material received under a Uniform Low-Level Radioactive Waste Manifest, the waste manifest number and the container identification with the nationally tracked source.

(4) Each licensee that disassembles a nationally tracked source shall complete and submit a National Source Tracking Transaction Report. The report must include the following information:

(a) The name, address, and license number of the reporting licensee;

(b) The name of the individual preparing the report;

(c) The manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;

(d) The radioactive material in the source;

(e) The initial or current source strength in becquerels (curies);

(f) The date for which the source strength is reported;

(g) The disassemble date of the source.

(5) Each licensee who disposes of a nationally tracked source shall complete and submit a National Source Tracking Transaction Report. The report must include the following information:

(a) The name, address, and license number of the reporting licensee;

(b) The name of the individual preparing the report;

(c) The waste manifest number;

(d) The container identification with the nationally tracked source;

(e) The date of disposal; and

(f) The method of disposal.

(6) The reports discussed in subsections (1) through (5) of this section must be submitted by the close of the next business day after the transaction. A single report may be submitted for multiple sources and transactions. The reports must be submitted to the National Source Tracking System by using:

(a) The online National Source Tracking System;

(b) Electronically using a computer-readable format;

(c) By facsimile;

(d) By mail to the address on the National Source Tracking Transaction Report Form (NRC Form 748); or

(e) By telephone with follow-up by facsimile or mail.

(7) Each licensee shall correct any error in previously filed reports or file a new report for any missed transaction within five business days of the discovery of the error or missed transaction. Such errors may be detected by a variety of methods such as administrative reviews or by physical inventories required by regulation. In addition, each licensee shall reconcile the inventory of nationally tracked sources possessed by the licensee against that licensee's data in the National Source Tracking System. The reconciliation must be conducted during the month of January in each year. The reconciliation process must include resolving any discrepancies between the National Source Tracking System and the actual inventory by filing the reports identified by subsections (1) through (5) of this section. By January 31, of each year, each licensee must submit to the National Source Tracking System confirmation that the data in the National Source Tracking System is correct.

(8) Each licensee that possesses Category 1 or 2 nationally tracked sources shall report its initial inventory of Category 1 or 2 nationally tracked sources to the National Source Tracking System by

January 31, 2009. The information may be submitted by using any of the methods identified in subsection (6)(a) through (d) of this section. The initial inventory report shall include the following information:

(a) The name, address, and license number of the reporting licensee;

(b) The name of the individual preparing the report;

(c) The manufacturer, model, and serial number of each nationally tracked source or, if not available, other information to uniquely identify the source;

(d) The radioactive material in the sealed source;

(e) The initial or current source strength in becquerels (curies); and

(f) The date for which the source strength is reported.

[Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 09-06-003, § 246-221-235, filed 2/18/09, effective 3/21/09.]

WAC 246-221-236 Nationally tracked source thresholds. The Tera-becquerel (TBq) values are the regulatory standard. The curie (Ci) values specified are obtained by converting from the TBq value. The curie values are provided for practical usefulness only and are rounded after conversion.

Radioactive Material	Category 1 (TBq)	Category 1 (Ci)	Category 2 (TBq)	Category 2 (Ci)
Actinium-227	20	540	0.2	5.4
Americium-241	60	1,600	0.6	16
Americium-241/Be	60	1,600	0.6	16
Californium-252	20	540	0.2	5.4
Cobalt-60	30	810	0.3	8.1
Cesium-137	100	2,700	1	27
Curium-244	50	1,400	0.5	14
Gadolinium-153	1,000	27,000	10	270
Iridium-192	80	2,200	0.8	22
Plutonium-238	60	1,600	0.6	16
Plutonium-239/Be	60	1,600	0.6	16
Polonium-210	60	1,600	0.6	16
Promethium-147	40,000	1,100,000	400	11,000
Radium-226	40	1,100	0.4	11
Selenium-75	200	5,400	2	54
Strontium-90	1,000	27,000	10	270
Thorium-228	20	540	0.2	5.4
Thorium-229	20	540	0.2	5.4
Thulium-170	20,000	540,000	200	5,400
Ytterbium-169	300	8,100	3	81

[Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 09-06-003, § 246-221-236, filed 2/18/09, effective 3/21/09.]

WAC 246-221-240 Reports of stolen, lost or missing radiation sources. (1) Each licensee and registrant shall report by telephone (206-682-5327) and confirm promptly by letter, facsimile, or email to the State Department of Health, Office of Radiation Protection, P.O. Box 47827, Olympia, Washington 98504-7827.

(a) Immediately after its occurrence becomes known to the licensee, stolen, lost, or missing radioactive material in an aggregate quantity equal to or greater than one thousand times the quantity specified in WAC 246-221-300, Appendix B; or

(b) Within thirty days after its occurrence becomes known to the licensee, lost, stolen, or missing radioactive material in an aggregate quantity greater than ten times the quantity specified in WAC 246-221-300, Appendix B that is still missing or any item not exempted in chapter 246-232 WAC; or

(c) Immediately after its occurrence becomes known to the registrant, a stolen, lost, or missing radiation machine.

(2) Each licensee or registrant required to make a report pursuant to subsection (1) of this section shall, within thirty days after making the telephone report, make a written report to the department setting forth the following information:

(a) 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; and

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

(c) A statement of disposition, or probable disposition, of the licensed or registered source of radiation involved; and

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

(e) Actions that have been taken, or will be taken, to recover the source of radiation; and

(f) 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.

(3) Subsequent to filing the written report, the licensee or registrant shall also report additional substantive information on the loss or theft within thirty days after the licensee or registrant learns of such information.

(4) The licensee or registrant shall prepare any report filed with the department pursuant to this section so that names of individuals who may have received exposure to radiation are stated in a separate and detachable portion of the report.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-221-240, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 14-01-077, § 246-221-240, filed 12/16/13, effective 1/16/14; WSR 94-01-073, § 246-221-240, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-

112 (Order 184), § 246-221-240, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-240, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-180, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-24-180, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-180, filed 12/8/80; Order 1095, § 402-24-180, filed 2/6/76; Order 708, § 402-24-180, filed 8/24/72; Order 1, § 402-24-180, filed 7/2/71; Order 1, § 402-24-180, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-250 Notification of incidents. (1) Immediate notification. Notwithstanding other requirements for notification, each licensee and registrant shall immediately (as soon as possible but no later than four hours after discovery of an incident) notify the State Department of Health, Office of Radiation Protection, P.O. Box 47827, Olympia, Washington 98504-7827, by telephone (206-682-5327) and confirming letter, facsimile, or email with a follow-up written report within thirty days of any incident involving any radiation source which may have caused or threatens to cause:

(a) An individual to receive:

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

(ii) A lens dose equivalent of 0.75 Sv (75 rem) or more; or

(iii) A shallow dose equivalent to the skin or extremities or a total organ dose equivalent of 2.5 Sv (250 rem) or more;

(b) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for twenty-four 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; or

(c) The loss of ability to take immediate protective actions necessary to avoid exposure to sources of radiation or releases of radioactive material that could exceed regulatory limits. Events which could cause such a loss of ability include fires, explosions, toxic gas releases, etc.

(2) **Twenty-four hour notification.** Each licensee and registrant shall within twenty-four hours of discovery of the event, notify the State Department of Health, Office of Radiation Protection, P.O. Box 47827, Olympia, Washington 98504-7827, by telephone (206-682-5327) and confirming letter, facsimile, or email with a follow-up written report

within thirty days of any incident involving any radiation source possessed which may have caused or threatens to cause:

(a) An individual to receive, in a period of twenty-four hours:

(i) A total effective dose equivalent exceeding 0.05 Sv (5 rem);

(ii) A lens dose equivalent exceeding 0.15 Sv (15 rem); or

(iii) A shallow dose equivalent to the skin or extremities or a total organ dose equivalent exceeding 0.5 Sv (50 rem);

(b) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for twenty-four 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;

(c) An unplanned contamination incident that:

(i) Requires access to the contaminated area, by workers or the general public, to be restricted for more than twenty-four hours by imposing additional radiological controls or by prohibiting entry into the area;

(ii) Involves a quantity of material greater than five times the lowest annual limit on intake specified in WAC 246-221-290; and

(iii) Has access to the area restricted for a reason other than to allow radionuclides with a half-life of less than twenty-four hours to decay prior to decontamination;

(d) Equipment failure or inability to function as designed when:

(i) The equipment is required by regulation or license condition to prevent releases exceeding regulatory limits, to prevent exposures to radiation and radioactive material exceeding regulatory limits or to mitigate the consequences of an accident;

(ii) The equipment is required to be available and operable at the time it becomes disabled or fails to function; and

(iii) No redundant equipment is available and operable to perform the required safety functions;

(e) An unplanned medical treatment at a medical facility of an individual with removable radioactive contamination on the individual's clothing or body; or

(f) An unplanned fire or explosion damaging any radioactive material or any device, container or equipment containing radioactive material when:

(i) The quantity of radioactive material involved is greater than five times the lowest annual limit on intake specified in WAC 246-221-290; and

(ii) The damage affects the integrity of the radioactive material or its container.

(3) For each occurrence requiring notification pursuant to this section, a prompt investigation of the situation shall be initiated by the licensee/registrant. A written report of the findings of the investigation shall be sent to the department within thirty days.

(4) The licensee or registrant shall prepare each report filed with the department under this section so that names of individuals who have received exposure to sources of radiation are stated in a separate and detachable portion of the report.

Any report filed with the department under this section shall contain the information described in WAC 246-221-260 (2) and (3).

(5) The provisions of this section 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 WAC 246-221-265.

(6) Telephone notifications that do not involve immediate or twenty-four hour notification should be made to the Tumwater office (360-236-3300).

(7) Telephone notification required under this section shall include, to the extent that the information is available at the time of notification:

(a) The caller's name and call-back telephone number;

(b) A description of the incident including date and time;

(c) The exact location of the incident;

(d) The radionuclides, quantities, and chemical and physical forms of the radioactive materials involved; and

(e) Any personnel radiation exposure data available.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-221-250, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 14-01-077, § 246-221-250, filed 12/16/13, effective 1/16/14; WSR 01-05-110, § 246-221-250, filed 2/21/01, effective 3/24/01; WSR 98-13-037, § 246-221-250, filed 6/8/98, effective 7/9/98; WSR 95-01-108, § 246-221-250, filed 12/21/94, effective 1/21/95; WSR 94-01-073, § 246-221-250, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-250, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-250, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-190, filed 12/11/86; WSR 83-19-

050 (Order 2026), § 402-24-190, filed 9/16/83. Statutory Authority:
RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-190, filed
12/8/80; Order 1095, § 402-24-190, filed 2/6/76; Order 708, § 402-24-
190, filed 8/24/72; Order 1, § 402-24-190, filed 7/2/71; Order 1, §
402-24-190, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-260 Reports of overexposures and excessive levels and concentrations. (1) In addition to any notification required by WAC 246-221-250, each licensee or registrant shall submit a written report to the department within thirty days after learning of any of the following occurrences:

(a) Incidents for which notification is required by WAC 246-221-250; or

(b) Doses in excess of any of the following:

(i) The occupational dose limits for adults in WAC 246-221-010;
or

(ii) The occupational dose limits for a minor in WAC 246-221-050;
or

(iii) The limits for an embryo/fetus of a declared pregnant woman in WAC 246-221-055; or

(iv) The limits for an individual member of the public in WAC 246-221-060; or

(v) Any applicable limit in the license; or

(vi) The ALARA constraints for air emissions established under WAC 246-221-005; or

(c) Levels of radiation or concentrations of radioactive material in:

(i) A restricted area in excess of applicable limits in the license; or

(ii) An unrestricted area in excess of ten times the applicable limit set forth in this chapter or in the license or registration, whether or not involving exposure of any individual in excess of the limits in WAC 246-221-060; or

(d) For source materials milling licensees and nuclear power plants subject to the provisions of United States Environmental Protection Agency's generally applicable environmental radiation standards in 40 C.F.R. 190, levels of radiation or releases of radioactive material in excess of those standards, or of license conditions related to those standards.

(2) Each report required by subsection (1) of this section shall describe:

(a) The incident and its exact location, time and date;

(b) The extent of exposure of individuals to radiation or to radioactive material, including estimates of each individual's dose as required by subsection (3) of this section;

(c) Levels of radiation and concentrations of radioactive material involved, including the radionuclides, quantities, and chemical and physical form;

(d) The cause or probable cause of the exposure, levels of radiation or concentrations;

(e) The manufacturer and model number (if applicable) of any equipment that failed or malfunctioned;

(f) The results of any evaluations or assessments; and

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

(3) Each report filed with the department pursuant to this section shall include for each individual exposed the name, Social Security number, and date of birth, and an estimate of the individual's dose. With respect to the limit for the embryo/fetus in WAC 246-221-055, 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 part of the report.

(4) Individuals shall be notified of reports in accordance with the requirements of WAC 246-222-040.

[Statutory Authority: RCW 70.98.050. WSR 99-15-105, § 246-221-260, filed 7/21/99, effective 8/21/99; WSR 95-01-108, § 246-221-260, filed 12/21/94, effective 1/21/95; WSR 94-01-073, § 246-221-260, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-260, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-260, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-200, filed 12/8/80; Order 1095, § 402-24-200, filed 2/6/76; Order 708, § 402-24-200, filed 8/24/72; Order 1, § 402-24-200, filed 7/2/71; Order 1, § 402-24-200, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-265 Special reports to the department—Planned special exposures and leaking sources. (1) The licensee or registrant shall submit a written report to the department within thirty days

following any planned special exposure conducted in accordance with WAC 246-221-030. The written report shall:

(a) Inform the department that a planned special exposure was conducted;

(b) Indicate the date the planned special exposure occurred; and

(c) Provide the information required by WAC 246-221-030.

(2) The licensee shall file a written report with the department within five days after learning that a sealed source is leaking or contaminated. The report shall describe:

(a) The source;

(b) The source holder;

(c) The equipment in which the source is installed;

(d) The test results; and

(e) The corrective action taken.

[Statutory Authority: RCW 70.98.050. WSR 99-05-013, § 246-221-265, filed 2/5/99, effective 3/8/99; WSR 94-01-073, § 246-221-265, filed 12/9/93, effective 1/9/94.]

WAC 246-221-270 Vacating premises and release of equipment. (1)

Each specific licensee shall notify the department in writing of intent to vacate, at least thirty days before vacating or relinquishing

possession or control of premises which may have been contaminated with radioactive material as a result of licensed activities.

(2) Each licensee shall permanently decontaminate the premise, before vacating any premise or transferring the premise, in accordance with the standards specified in chapter 246-246 WAC. A survey by the licensee shall be made after the decontamination and the department and the landlord or subsequent tenant or transferee shall be provided with a copy of the survey no later than the date of vacating or relinquishing possession or control of the premise.

(3) No machinery, instruments, laboratory equipment or any other property used in contact with, or close proximity to radioactive material at a licensed premise shall be assigned, sold, leased, or transferred to an unlicensed person unless the property has been decontaminated and meets the standards specified in WAC 246-232-140. A survey shall be made after the decontamination and the department and subsequent owner or transferee shall be provided with a copy of the survey report.

[Statutory Authority: RCW 70.98.050. WSR 00-07-085, § 246-221-270, filed 3/15/00, effective 4/15/00; WSR 94-01-073, § 246-221-270, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-270, filed 12/27/90, ef-

fective 1/31/91; Order 1095, § 402-24-210, filed 2/6/76; Order 1, § 402-24-210, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-221-275 Notification of changes in a facility. Each licensee or registrant shall notify the department of changes in any room or area in a facility where a source of radiation is used. Changes of interest to the department include, but are not limited to, new or replacement equipment containing or emitting radiation, increased occupancy, repair or replacement of existing shielding, new shielding, alteration of the ventilation system, and changes in procedures done in the room or area.

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-275, filed 12/9/93, effective 1/9/94.]

WAC 246-221-280 Notifications and reports to individuals. (1) Requirements for notification and reports to individuals of exposure to radiation or radioactive material are specified in WAC 246-222-040.

(2) When a licensee or registrant is required pursuant to WAC 246-221-260 to report to the department any exposure of an identified occupationally exposed individual, or an identified member of the public, or dosimetry device assigned to any individual to radiation from

any source, the licensee or registrant shall also notify the individual. Such notice shall be transmitted at a time not later than the transmittal to the department, and shall comply with the provisions of WAC 246-222-040(1).

[Statutory Authority: RCW 70.98.050. WSR 99-05-012, § 246-221-280, filed 2/5/99, effective 3/8/99. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-280, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-221-280, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-24-215, filed 12/11/86; Order 1095, § 402-24-215, filed 2/6/76.]

WAC 246-221-285 Assigned protection factors for respirators.^a

	Operating mode	Assigned Protection Factors
I. Air-Purifying Respirators (Particulate ^b only) ^c :		
Filtering facepiece disposable ^d	Negative Pressure	(4)
Facepiece, half ^e	Negative Pressure	10
Facepiece, full	Negative Pressure	100
Facepiece, half	Powered air-purifying respirators	50
Facepiece, full	Powered air-purifying respirators	1000
Helmet/hood	Powered air-purifying respirators	1000
Facepiece, loose-fitting	Powered air-purifying respirators	25
II. Atmosphere-Supplying Respirators (Particulate, gases and vapors ^f):		
1. Air-line respirator:		
Facepiece, half	Demand	10
Facepiece, half	Continuous Flow	50
Facepiece, half	Pressure Demand	50
Facepiece, full	Demand	100

	Operating mode	Assigned Protection Factors
Facepiece, full	Continuous Flow	1000
Facepiece, full	Pressure Demand	1000
Helmet/hood	Continuous Flow	1000
Facepiece, loose-fitting	Continuous Flow	25
Suit	Continuous Flow	(g)
2. Self-contained breathing apparatus (SCBA):		
Facepiece, full	Demand	^h 100
Facepiece, full	Pressure Demand	ⁱ 10,000
Facepiece, full	Demand, Recirculating	^h 100
Facepiece, full	Positive Pressure Recirculating	ⁱ 10,000
III. Combination Respirators:		
Any combination of air-purifying and atmosphere-supplying respirators.	Assigned protection factor for type and mode of operation as listed above.	

- ^a These assigned protection factors apply only in a respiratory protection program that meets the requirements of this chapter. They are applicable only to airborne radiological hazards and may not be appropriate to circumstances when chemical or other respiratory hazards exist instead of, or in addition to, radioactive hazards. Selection and use of respirators for these circumstances must also comply with Department of Labor regulations.
- Radioactive contaminants for which the concentration values in Table 1, Column 3 of WAC 246-221-290, Appendix A, are based on internal dose due to inhalation may, in addition, present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.
- ^b Air-purifying respirators with APF <100 must be equipped with particulate filters that are at least 95 percent efficient. Air-purifying respirators with APF = 100 must be equipped with particulate filters that are at least 99 percent efficient. Air-purifying respirators with APFs >100 must be equipped with particulate filters that are at least 99.97 percent efficient.
- ^c The licensee may apply to the department for the use of an APF greater than 1 for sorbent cartridges as protection against airborne radioactive gases and vapors (e.g., radioiodine).
- ^d Licensees may permit individuals to use this type of respirator who have not been medically screened or fit tested on the device provided that no credit be taken for their use in estimating intake or dose. It is also recognized that it is difficult to perform an effective positive or negative pressure preuse user seal check on this type of device. All other respiratory protection program requirements listed in WAC 246-221-117 apply. An assigned protection factor has not been assigned for these devices. However, an APF equal to 10 may be used if the licensee can demonstrate a fit factor of at least 100 by use of a validated or evaluated, qualitative or quantitative fit test.
- ^e Under-chin type only. No distinction is made in this section between elastomeric half-masks with replaceable cartridges and those designed with the filter medium as an integral part of the facepiece (e.g., disposable or reusable disposable). Both types are acceptable so long as the seal area of the latter contains some substantial type of seal-enhancing material such as rubber or plastic, the two or more suspension straps are adjustable, the filter medium is at least 95 percent efficient and all other requirements of this part are met.
- ^f The assigned protection factors for gases and vapors are not applicable to radioactive contaminants that present an absorption or submersion hazard. For tritium oxide vapor, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of 3 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. Exposure to radioactive noble gases is not considered a significant respiratory hazard, and protective actions for these contaminants should be based on external (submersion) dose considerations.
- ^g No NIOSH approval schedule is currently available for atmosphere-supplying suits. This equipment may be used in an acceptable respiratory protection program as long as all the other minimum program requirements, with the exception of fit testing, are met (i.e., WAC 246-221-117).
- ^h The licensee should implement institutional controls to assure that these devices are not used in areas immediately dangerous to life or health (IDLH).
- ⁱ This type of respirator may 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 shall be taken into account in these circumstances. This device may not be used by any individual who experiences perceptible outward leakage of breathing gas while wearing the device.

[Statutory Authority: RCW 70.98.050. WSR 01-05-110, § 246-221-285, filed 2/21/01, effective 3/24/01; WSR 94-01-073, § 246-221-285, filed 12/9/93, effective 1/9/94.]

WAC 246-221-290 Appendix A—Annual limits on intake (ALI) and derived air concentrations (DAC) of radionuclides for occupational expo-

sure; effluent concentrations; concentrations for release to sanitary sewerage. 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 ten days, for W from ten to one hundred days, and for Y greater than one hundred days. 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: A committed effective dose equivalent of 0.05 Sv (5 rem), stochastic ALI; or a

committed dose equivalent of 0.5 Sv (50 rem) to an organ or tissue, nonstochastic 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 WAC 246-221-005. The nonstochastic ALIs were derived to avoid nonstochastic 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, elbows, arms below the elbows, feet and lower legs, knees, and legs below the knees,

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;
Blad wall	=	bladder wall; and
Bone surf	=	bone surface.

The use of the ALIs listed first, the more limiting of the stochastic and nonstochastic ALIs, will ensure that nonstochastic 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 nonstochastic 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 (intake (in μCi) of each radionuclide/ ALI_{ns}) ≤ 1.0 . If there is an external deep dose equivalent contribution of H_a , then this sum must be less than $1 - (H_a/50)$, 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 per minute 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 in-

clude 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 WAC 246-221-015. 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 WAC 246-221-070. 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 0.50 mSv (0.05 rem).

Consideration of nonstochastic limits has not been included in deriving the air and water effluent concentration limits because nonstochastic effects are presumed not to occur at or below the dose levels established for individual members of the public. For radionuclides, where the nonstochastic 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 the previous Appendix A of this chapter.

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 , relating the inhalation ALI to the DAC, as explained above, and then divided by a factor of three hundred. The factor of three hundred includes the following components: A factor of fifty 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 three 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 two to adjust the occupational values, derived for adults, so that they are applicable to other age groups.

For those radionuclides for which submersion, that is external dose, is limiting, the occupational DAC in Table I, Column 3 was divided by two hundred nineteen. The factor of two hundred nineteen is composed of a factor of fifty, as described above, and a factor of 4.38 relating occupational exposure for two thousand hours per year to full-time exposure (eight thousand seven hundred sixty hours per year). Note that an additional factor of two 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 fifty and two described above and a factor of 7.3×10^5 (ml) which is the annual water intake of Reference Man.

Note 2 of this appendix provides groupings of radionuclides which are applicable to unknown mixtures of radionuclides. These groupings, including occupational inhalation ALIs and DACs, air and water effluent concentrations and 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 WAC 246-221-190. 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 ten, 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 5 mSv (0.5 rem).

LIST OF ELEMENTS

Name	Symbol	Atomic Number	Name	Symbol	Atomic Number
Actinium	Ac	89	Molybdenum	Mo	42
Aluminum	Al	13	Neodymium	Nd	60
Americium	Am	95	Neptunium	Np	93
Antimony	Sb	51	Nickel	Ni	28
Argon	Ar	18	Nitrogen	N	7
Arsenic	As	33	Niobium	Nb	41
Astatine	At	85	Osmium	Os	76
Barium	Ba	56	Oxygen	O	8
Berkelium	Bk	97	Palladium	Pd	46
Beryllium	Be	4	Phosphorus	P	15
Bismuth	Bi	83	Platinum	Pt	78
Bromine	Br	35	Plutonium	Pu	94
Cadmium	Cd	48	Polonium	Po	84
Calcium	Ca	20	Potassium	K	19

LIST OF ELEMENTS

Name	Symbol	Atomic Number	Name	Symbol	Atomic Number
Californium	Cf	98	Praseodymium	Pr	59
Carbon	C	6	Promethium	Pm	61
Cerium	Ce	58	Protactinium	Pa	91
Cesium	Cs	55	Radium	Ra	88
Chlorine	Cl	17	Radon	Rn	86
Chromium	Cr	24	Rhenium	Re	75
Cobalt	Co	27	Rhodium	Rh	45
Copper	Cu	29	Rubidium	Rb	37
Curium	Cm	96	Ruthenium	Ru	44
Dysprosium	Dy	66	Samarium	Sm	62
Einsteinium	Es	99	Scandium	Sc	21
Erbium	Er	68	Selenium	Se	34
Europium	Eu	63	Silicon	Si	14
Fermium	Fm	100	Silver	Ag	47
Fluorine	F	9	Sodium	Na	11
Francium	Fr	87	Strontium	Sr	38
Gadolinium	Gd	64	Sulfur	S	16
Gallium	Ga	31	Tantalum	Ta	73
Germanium	Ge	32	Technetium	Tc	43
Gold	Au	79	Tellurium	Te	52
Hafnium	Hf	72	Terbium	Tb	65
Holmium	Ho	67	Thallium	Tl	81
Hydrogen	H	1	Thorium	Th	90
Indium	In	49	Thulium	Tm	69
Iodine	I	53	Tin	Sn	50
Iridium	Ir	77	Titanium	Ti	22
Iron	Fe	26	Tungsten	W	74
Krypton	Kr	36	Uranium	U	92
Lanthanum	La	57	Vanadium	V	23
Lead	Pb	82	Xenon	Xe	54
Lutetium	Lu	71	Ytterbium	Yb	70
Magnesium	Mg	12	Yttrium	Y	39
Manganese	Mn	25	Zinc	Zn	30
Mendelevium	Md	101	Zirconium	Zr	40
Mercury	Hg	80			

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation ALI μCi DAC μCi/ml		Air μCi/ml	Water μCi/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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
6	Carbon-11 ²	Y, see ⁷ Be	-	1E+1	6E-9	2E-11	-	-
		Monoxide	-	1E+6	5E-4	2E-6	-	-
		Dioxide	-	6E+5	3E-4	9E-7	-	-
6	Carbon-14	Compounds	4E+5	4E+5	2E-4	6E-7	6E-3	6E-2
		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
7	Nitrogen-13 ²	Submersion ¹	-	-	4E-6	2E-8	-	-
8	Oxygen-15 ²	Submersion ¹	-	-	4E-6	2E-8	-	-
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	-	-
14	Silicon-32	Y, aluminosilicate glass	-	3E+4	1E-5	4E-8	-	-
		D, see ³¹ Si	2E+3	2E+2	1E-7	3E-10	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
15	Phosphorus-32	W, see ³¹ Si	-	1E+2	5E-8	2E-10	-	-
		Y, see ³¹ Si	-	5E+0	2E-9	7E-12	-	-
		D, all compounds except phosphates given for W	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
15	Phosphorus-33	W, phosphates of Zn ²⁺ , S ³⁺ , Mg ²⁺ , Fe ³⁺ , Bi ³⁺ , and lanthanides	-	4E+2	2E-7	5E-10	-	-
		D, see ³² P	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4
16	Sulfur-35	W, see ³² P	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	1E+4	6E-6	2E-8	-	-
		D, sulfides and sulfates except those given for W	1E+4	2E+4	7E-6	2E-8	-	-
			LLI wall (8E+3)	-	-	-	1E-4	1E-3
		W, elemental sulfur, sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, and Mo. Sulfates of Ca, Sr, Ba, Ra, As, Sb, and Bi	6E+3	-	-	-	-	-
			-	2E+3	9E-7	3E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, chlorides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, and Re	-	2E+2	1E-7	3E-10	-	-
17	Chlorine-38 ²	D, see ³⁶ Cl	2E+4	4E+4	2E-5	6E-8	-	-
		St wall (3E+4)	-	-	-	-	3E-4	3E-3
		W, see ³⁶ Cl	-	5E+4	2E-5	6E-8	-	-
17	Chlorine-39 ²	D, see ³⁶ Cl	2E+4	5E+4	2E-5	7E-8	-	-
		St wall (4E+4)	-	-	-	-	5E-4	5E-3
		W, see ³⁶ Cl	-	6E+4	2E-5	8E-8	-	-
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 (4E+3)	-	Bone surf (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	3E+3	1E-6	4E-9	-	-
		LLI wall (3E+3)	-	-	-	-	4E-5	4E-4
21	Scandium-48	Y, all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
21	Scandium-49 ²	Y, all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
22	Titanium-44	D, all compounds except those given for W and Y	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	3E+1	1E-8	4E-11	-	-
		Y, SrTiO	-	6E+0	2E-9	8E-12	-	-
22	Titanium-45	D, see ⁴⁴ Ti	9E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		W, see ⁴⁴ Ti	-	4E+4	1E-5	5E-8	-	-
		Y, see ⁴⁴ Ti	-	3E+4	1E-5	4E-8	-	-
23	Vanadium-472	D, all compounds except those given for W	3E+4	8E+4	3E-5	1E-7	-	-
		St wall (3E+4)	-	-	-	-	4E-4	4E-3
		W, oxides, hydroxides, carbides, and halides	-	1E+5	4E-5	1E-7	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
23	Vanadium-48	D, see ⁴⁷ V	6E+2	1E+3	5E-7	2E-9	9E-6	9E-5
		W, see ⁴⁷ V	-	6E+2	3E-7	9E-10	-	-
23	Vanadium-49	D, see ⁴⁷ V	7E+4	3E+4	1E-5	-	-	-
		LLI wall (9E+4)	-	Bone surf (3E+4)	-	5E-8	1E-3	1E-2
24	Chromium-48	W, see ⁴⁷ V	-	2E+4	8E-6	2E-8	-	-
		D, all compounds except those given for W and Y	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, halides and nitrates	-	7E+3	3E-6	1E-8	-	-
24	Chromium-49 ²	Y, oxides and hydroxides	-	7E+3	3E-6	1E-8	-	-
		D, see ⁴⁸ Cr	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
		W, see ⁴⁸ Cr	-	1E+5	4E-5	1E-7	-	-
24	Chromium-51	Y, see ⁴⁸ Cr	-	9E+4	4E-5	1E-7	-	-
		D, see ⁴⁸ Cr	4E+4	5E+4	2E-5	6E-8	5E-4	5E-3
		W, see ⁴⁸ Cr	-	2E+4	1E-5	3E-8	-	-
25	Manganese-51 ²	Y, see ⁴⁸ Cr	-	2E+4	8E-6	3E-8	-	-
		D, all compounds except those given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	8E-8	-	-
25	Manganese-52m ²	D, see 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
		Bone surf (2E+4)	-	-	-	3E-8	-	-
		W, see ⁵¹ Mn	-	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 ⁵⁵ Co	5E+2	3E+2	1E-7	4E-10	6E-6	6E-5
		Y, see ⁵⁵ Co	4E+2	2E+2	8E-8	3E-10	-	-
27	Cobalt-57	W, see ⁵⁵ Co	8E+3	3E+3	1E-6	4E-9	6E-5	6E-4
		Y, see ⁵⁵ Co	4E+3	7E+2	3E-7	9E-10	-	-
27	Cobalt-58m	W, see ⁵⁵ Co	6E+4	9E+4	4E-5	1E-7	8E-4	8E-3
		Y, see ⁵⁵ Co	-	6E+4	3E-5	9E-8	-	-
27	Cobalt-58	W, see ⁵⁵ Co	2E+3	1E+3	5E-7	2E-9	2E-5	2E-4

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
27	Cobalt-60m ²	Y, see ⁵⁵ Co	1E+3	7E+2	3E-7	1E-9	-	-
		W, see ⁵⁵ Co	1E+6	4E+6	2E-3	6E-6	-	-
27	Cobalt-60	St wall (1E+6)	-	-	-	-	2E-2	2E-1
		Y, see ⁵⁵ Co	-	3E+6	1E-3	4E-6	-	-
27	Cobalt-61 ²	W, see ⁵⁵ Co	5E+2	2E+2	7E-8	2E-10	3E-6	3E-5
		Y, see ⁵⁵ Co	2E+2	3E+1	1E-8	5E-11	-	-
27	Cobalt-62m ²	W, see ⁵⁵ Co	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ⁵⁵ Co	2E+4	6E+4	2E-5	8E-8	-	-
28	Nickel-56	W, see ⁵⁵ Co	4E+4	2E+5	7E-5	2E-7	-	-
		St wall (5E+4)	-	-	-	-	7E-4	7E-3
28	Nickel-57	Y, see ⁵⁵ Co	-	2E+5	6E-5	2E-7	-	-
		D, all compounds except those given for W	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
28	Nickel-59	W, oxides, hydroxides, and carbides	-	1E+3	5E-7	2E-9	-	-
		Vapor	-	1E+3	5E-7	2E-9	-	-
28	Nickel-63	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	-	-
28	Nickel-65	Vapor	-	6E+3	3E-6	9E-9	-	-
		D, see ⁵⁶ Ni	2E+4	4E+3	2E-6	5E-9	3E-4	3E-3
28	Nickel-66	W, see ⁵⁶ Ni	-	7E+3	3E-6	1E-8	-	-
		Vapor	-	2E+3	8E-7	3E-9	-	-
28	Nickel-67	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	-	-
28	Nickel-68	Vapor	-	8E+2	3E-7	1E-9	-	-
		D, see ⁵⁶ Ni	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
28	Nickel-69	W, see ⁵⁶ Ni	-	3E+4	1E-5	4E-8	-	-
		Vapor	-	2E+4	7E-6	2E-8	-	-
29	Copper-60 ²	D, see ⁵⁶ Ni	4E+2	2E+3	7E-7	2E-9	-	-
		LLI wall (5E+2)	-	-	-	-	6E-6	6E-5
29	Copper-64	W, see ⁵⁶ Ni	-	6E+2	3E-7	9E-10	-	-
		Vapor	-	3E+3	1E-6	4E-9	-	-
29	Copper-66	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
29	Copper-67	W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	4E-5	1E-7	-	-
29	Copper-68	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	-	-
29	Copper-69	Y, see ⁶⁰ Cu	-	4E+4	1E-5	5E-8	-	-
		D, see ⁶⁰ Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
29	Copper-70	W, see ⁶⁰ Cu	-	2E+4	1E-5	3E-8	-	-
		Y, see ⁶⁰ Cu	-	2E+4	9E-6	3E-8	-	-
30	Zinc-62	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	-	-
30	Zinc-63 ²	Y, see ⁶⁰ Cu	-	5E+3	2E-6	6E-9	-	-
		Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
30	Zinc-64 ²	Y, all compounds	2E+4	7E+4	3E-5	9E-8	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
			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
30	Zinc-72	Y, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
31	Gallium-65 ²	D, all compounds except [except] those given for W	5E+4	2E+5	7E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	9E-4	9E-3
		W, oxides, hydroxides, carbides, halides, and nitrates	-	2E+5	8E-5	3E-7	-	-
31	Gallium-66	D, see ⁶⁵ Ga	1E+3	4E+3	1E-6	5E-9	1E-5	1E-4
		W, see ⁶⁵ Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-67	D, see ⁶⁵ Ga	7E+3	1E+4	6E-6	2E-8	1E-4	1E-3
		W, see ⁶⁵ Ga	-	1E+4	4E-6	1E-8	-	-
31	Gallium-68 ²	D, see ⁶⁵ Ga	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ⁶⁵ Ga	-	5E+4	2E-5	7E-8	-	-
31	Gallium-70 ²	D, see ⁶⁵ Ga	5E+4	2E+5	7E-5	2E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
		W, see ⁶⁵ Ga	-	2E+5	8E-5	3E-7	-	-
31	Gallium-72	D, see ⁶⁵ Ga	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ⁶⁵ Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-73	D, see ⁶⁵ Ga	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ⁶⁵ Ga	-	2E+4	6E-6	2E-8	-	-
32	Germanium-66	D, all compounds except those given for W	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
		W, oxides, sulfides, and halides	-	2E+4	8E-6	3E-8	-	-
32	Germanium-67 ²	D, see ⁶⁶ Ge	3E+4	9E+4	4E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
		W, see ⁶⁶ Ge	-	1E+5	4E-5	1E-7	-	-
32	Germanium-68	D, see ⁶⁶ Ge	5E+3	4E+3	2E-6	5E-9	6E-5	6E-4
		W, see ⁶⁶ Ge	-	1E+2	4E-8	1E-10	-	-
32	Germanium-69	D, see ⁶⁶ Ge	1E+4	2E+4	6E-6	2E-8	2E-4	2E-3
		W, see ⁶⁶ Ge	-	8E+3	3E-6	1E-8	-	-
32	Germanium-71	D, see ⁶⁶ Ge	5E+5	4E+5	2E-4	6E-7	7E-3	7E-2
		W, see ⁶⁶ Ge	-	4E+4	2E-5	6E-8	-	-
32	Germanium-75 ²	D, see ⁶⁶ Ge	4E+4	8E+4	3E-5	1E-7	-	-
			St wall (7E+4)	-	-	-	9E-4	9E-3
		W, see ⁶⁶ Ge	-	8E+4	4E-5	1E-7	-	-
32	Germanium-77	D, see ⁶⁶ Ge	9E+3	1E+4	4E-6	1E-8	1E-4	1E-3
		W, see ⁶⁶ Ge	-	6E+3	2E-6	8E-9	-	-
32	Germanium-78 ²	D, see ⁶⁶ Ge	2E+4	2E+4	9E-6	3E-8	-	-
			St wall (2E+4)	-	-	-	3E-4	3E-3
		W, see ⁶⁶ Ge	-	2E+4	9E-6	3E-8	-	-
33	Arsenic-69 ²	W, all compounds	3E+4	1E+5	5E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
33	Arsenic-70 ²	W, all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
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	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and elemental Se	1E+4	4E+4	2E-5	6E-8	-	-
34	Selenium-73m ²	D, see ⁷⁰ Se	6E+4	2E+5	6E-5	2E-7	4E-4	4E-3
		W, see ⁷⁰ Se	3E+4	1E+5	6E-5	2E-7	-	-
34	Selenium-73	D, see ⁷⁰ Se	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
		W, see ⁷⁰ Se	-	2E+4	7E-6	2E-8	-	-
34	Selenium-75	D, see ⁷⁰ Se	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
		W, see ⁷⁰ Se	-	6E+2	3E-7	8E-10	-	-
34	Selenium-79	D, see ⁷⁰ Se	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
		W, see ⁷⁰ Se	-	6E+2	2E-7	8E-10	-	-
34	Selenium-81m ²	D, see ⁷⁰ Se	4E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, see ⁷⁰ Se	2E+4	7E+4	3E-5	1E-7	-	-
34	Selenium-81 ²	D, see ⁷⁰ Se	6E+4	2E+5	9E-5	3E-7	-	-
			St wall (8E+4)	-	-	-	1E-3	1E-2
		W, see ⁷⁰ Se	-	2E+5	1E-4	3E-7	-	-
34	Selenium-83 ²	D, see ⁷⁰ Se	4E+4	1E+5	5E-5	2E-7	4E-4	4E-3
		W, see ⁷⁰ Se	3E+4	1E+5	5E-5	2E-7	-	-
35	Bromine-74m ²	D, bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4	4E+4	2E-5	5E-8	-	-
			St wall (2E+4)	-	-	-	3E-4	3E-3
		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	-	4E+4	2E-5	6E-8	-	-
35	Bromine-74 ²	D, see ^{74m} Br	2E+4	7E+4	3E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	5E-45E-3	-
		W, see ^{74m} Br	-	8E+4	4E-5	1E-7	-	-
35	Bromine-75 ²	D, see ^{74m} Br	3E+4	5E+4	2E-5	7E-8	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m} Br	-	5E+4	2E-5	7E-8	-	-
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	2E+5	8E-5	3E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
35	Bromine-82	W, see ^{74m} Br	-	2E+5	9E-5	3E-7	-	-
		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	6E+4	3E-5	9E-8	-	-
		St wall (7E+4)	-	-	-	-	9E-4	9E-3
		W, see ^{74m} Br	-	6E+4	3E-5	9E-8	-	-
35	Bromine-84 ²	D, see ^{74m} Br	2E+4	6E+4	2E-5	8E-8	-	-
		St wall (3E+4)	-	-	-	-	4E-4	4E-3
		W, see ^{74m} Br	-	6E+4	3E-5	9E-8	-	-
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	1E+5	5E-5	2E-7	-	-
		St wall (6E+4)	-	-	-	-	8E-4	8E-3
		D, all compounds	2E+5	3E+5	1E-4	5E-7	-	-
37	Rubidium-81m ²	St wall (3E+5)	-	-	-	-	4E-3	4E-2
		D, all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
		D, all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3
37	Rubidium-83	D, all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5
37	Rubidium-84	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-86	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-87	D, all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
37	Rubidium-88 ²	D, all compounds	2E+4	6E+4	3E-5	9E-8	-	-
		St wall (3E+4)	-	-	-	-	4E-4	4E-3
		D, all compounds	4E+4	1E+5	6E-5	2E-7	-	-
37	Rubidium-89 ²	St wall (6E+4)	-	-	-	-	9E-4	9E-3
		D, all soluble compound except SrTiO	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		Y, all insoluble compounds and SrTiO	-	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	4E+2	2E-7	6E-10	-	-
		LLI wall (2E+2)	-	-	-	-	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

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
38	Strontium-87m	Y, see ⁸⁰ Sr	-	2E+3	6E-7	2E-9	-	-
		D, see ⁸⁰ Sr	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
38	Strontium-89	Y, see ⁸⁰ Sr	4E+4	2E+5	6E-5	2E-7	-	-
		D, see ⁸⁰ Sr	6E+2	8E+2	4E-7	1E-9	-	-
38	Strontium-90	LLI wall (6E+2)	-	-	-	-	8E-6	8E-5
		Y, see ⁸⁰ Sr	5E+2	1E+2	6E-8	2E-10	-	-
		D, see ⁸⁰ Sr	3E+1	2E+1	8E-9	-	-	-
		Bone surf (4E+1)	Bone surf (2E+1)	-	3E-11	5E-7	5E-6	
38	Strontium-91	Y, see ⁸⁰ Sr	-	4E+0	2E-9	6E-12	-	-
		D, see ⁸⁰ Sr	2E+3	6E+3	2E-6	8E-9	2E-5	2E-4
38	Strontium-92	Y, see ⁸⁰ Sr	-	4E+3	1E-6	5E-9	-	-
		D, see ⁸⁰ Sr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
39	Yttrium-86m ²	Y, see ⁸⁰ Sr	-	7E+3	3E-6	9E-9	-	-
		W, all compounds except those given for Y	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
39	Yttrium-86	Y, oxides and hydroxides	-	5E+4	2E-5	8E-8	-	-
		W, see ^{86m} Y	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
39	Yttrium-87	Y, see ^{86m} Y	-	3E+3	1E-6	5E-9	-	-
		W, see ^{86m} Y	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
39	Yttrium-88	Y, see ^{86m} Y	-	3E+3	1E-6	5E-9	-	-
		W, see ^{86m} Y	1E+3	3E+2	1E-7	3E-10	1E-5	1E-4
39	Yttrium-90m	Y, see ^{86m} Y	-	2E+2	1E-7	3E-10	-	-
		W, see ^{86m} Y	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
39	Yttrium-90	Y, see ^{86m} Y	-	1E+4	5E-6	2E-8	-	-
		W, see ^{86m} Y	4E+2	7E+2	3E-7	9E-10	-	-
		LLI wall (5E+2)	-	-	-	-	7E-6	7E-5
		Y, see ^{86m} Y	-	6E+2	3E-7	9E-10	-	-
39	Yttrium-91m ²	W, see ^{86m} Y	1E+5	2E+5	1E-4	3E-7	2E-3	2E-2
		Y, see ^{86m} Y	-	2E+5	7E-5	2E-7	-	-
39	Yttrium-91	W, see ^{86m} Y	5E+2	2E+2	7E-8	2E-10	-	-
		LLI wall (6E+2)	-	-	-	-	8E-6	8E-5
39	Yttrium-92	Y, see ^{86m} Y	-	1E+2	5E-8	2E-10	-	-
		W, see ^{86m} Y	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
39	Yttrium-93	Y, see ^{86m} Y	-	8E+3	3E-6	1E-8	-	-
		W, see ^{86m} Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
39	Yttrium-94 ²	Y, see ^{86m} Y	-	2E+3	1E-6	3E-9	-	-
		W, see ^{86m} Y	2E+4	8E+4	3E-5	1E-7	-	-
39	Yttrium-95 ²	St wall (3E+4)	-	-	-	-	4E-4	4E-3
		Y, see ^{86m} Y	-	8E+4	3E-5	1E-7	-	-
		W, see ^{86m} Y	4E+4	2E+5	6E-5	2E-7	-	-
		St wall (5E+4)	-	-	-	-	7E-4	7E-3
40	Zirconium-86	Y, see ^{86m} Y	-	1E+5	6E-5	2E-7	-	-
		D, all compounds except those given for W and Y	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
40	Zirconium-88	Y, carbide	-	2E+3	1E-6	3E-9	-	-
		D, see ⁸⁶ Zr	4E+3	2E+2	9E-8	3E-10	5E-5	5E-4

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
40	Zirconium-89	W, see ⁸⁶ Zr	-	5E+2	2E-7	7E-10	-	-
		Y, see ⁸⁶ Zr	-	3E+2	1E-7	4E-10	-	-
		D, see ⁸⁶ Zr	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
40	Zirconium-93	W, see ⁸⁶ Zr	-	2E+3	1E-6	3E-9	-	-
		Y, see ⁸⁶ Zr	-	2E+3	1E-6	3E-9	-	-
		D, see ⁸⁶ Zr	1E+3	6E+0	3E-9	-	-	-
40	Zirconium-95	Bone surf (3E+3)	-	Bone surf (2E+1)	-	2E-11	4E-5	4E-4
		W, see ⁸⁶ Zr	-	2E+1	1E-8	-	-	-
		Y, see ⁸⁶ Zr	-	Bone surf (6E+1)	-	9E-11	-	-
40	Zirconium-97	D, see ⁸⁶ Zr	1E+3	1E+2	5E-8	-	2E-5	2E-4
		W, see ⁸⁶ Zr	-	Bone surf (3E+2)	-	4E-10	-	-
		Y, see ⁸⁶ Zr	-	4E+2	2E-7	5E-10	-	-
40	Zirconium-97	D, see ⁸⁶ Zr	6E+2	2E+3	8E-7	3E-9	9E-6	9E-5
		W, see ⁸⁶ Zr	-	3E+2	1E-7	4E-10	-	-
		Y, see ⁸⁶ Zr	-	1E+3	6E-7	2E-9	-	-
41	Niobium-88 ²	W, all compounds except those given for Y	5E+4	2E+5	9E-5	3E-7	-	-
		St wall (7E+4)	-	-	-	-	1E-3	1E-2
		Y, oxides and hydroxides	-	2E+5	9E-5	3E-7	-	-
41	Niobium-89 ² (66 min)	W, see ⁸⁸ Nb	1E+4	4E+4	2E-5	6E-8	1E-4	1E-3
41	Niobium-89 (122 min)	Y, see ⁸⁸ Nb	-	4E+4	2E-5	5E-8	-	-
41	Niobium-90	W, see ⁸⁸ Nb	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
41	Niobium-93m	Y, see ⁸⁸ Nb	-	2E+4	6E-6	2E-8	-	-
41	Niobium-94	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	-	-
		W, see ⁸⁸ Nb	9E+3	2E+3	8E-7	3E-9	-	-
41	Niobium-95	LLI wall (1E+4)	-	-	-	-	2E-4	2E-3
		Y, see ⁸⁸ Nb	-	2E+2	7E-8	2E-10	-	-
		W, see ⁸⁸ Nb	9E+2	2E+2	8E-8	3E-10	1E-5	1E-4
41	Niobium-95m	Y, see ⁸⁸ Nb	-	2E+1	6E-9	2E-11	-	-
		W, see ⁸⁸ Nb	2E+3	3E+3	1E-6	4E-9	-	-
		LLI wall (2E+3)	-	-	-	-	3E-5	3E-4
41	Niobium-96	Y, see ⁸⁸ Nb	-	2E+3	9E-7	3E-9	-	-
		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-97 ²	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	-	-
		W, see ⁸⁸ Nb	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
41	Niobium-98 ²	Y, see ⁸⁸ Nb	-	7E+4	3E-5	1E-7	-	-
		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

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
		Y, oxides, hydroxides, and MoS	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	3E+3	1E-6	4E-9	-	-
		LLI wall (1E+3)	-	-	-	-	2E-5	2E-4
		Y, see ⁹⁰ Mo	1E+3	1E+3	6E-7	2E-9	-	-
42	Molybdenum-101 ²	D, see ⁹⁰ Mo	4E+4	1E+5	6E-5	2E-7	-	-
		St wall (5E+4)	-	-	-	-	7E-4	7E-3
		Y, see ⁹⁰ Mo	-	1E+5	6E-5	2E-7	-	-
43	Technetium-93m ²	D, all compounds except those given for W	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, and nitrates	-	3E+5	1E-4	4E-7	-	-
43	Technetium-93	D, see ^{93m} Tc	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		W, see ^{93m} Tc	-	1E+5	4E-5	1E-7	-	-
43	Technetium-94m ²	D, see ^{93m} Tc	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{93m} Tc	-	6E+4	2E-5	8E-8	-	-
43	Technetium-94	D, see ^{93m} Tc	9E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{93m} Tc	-	2E+4	1E-5	3E-8	-	-
43	Technetium-95m	D, see ^{93m} Tc	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		W, see ^{93m} Tc	-	2E+3	8E-7	3E-9	-	-
43	Technetium-95	D, see ^{93m} Tc	1E+4	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{93m} Tc	-	2E+4	8E-6	3E-8	-	-
43	Technetium-96m ²	D, see ^{93m} Tc	2E+5	3E+5	1E-4	4E-7	2E-3	2E-2
		W, see ^{93m} Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-96	D, see ^{93m} Tc	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		W, see ^{93m} Tc	-	2E+3	9E-7	3E-9	-	-
43	Technetium-97m	D, see ^{93m} Tc	5E+3	7E+3	3E-6	-	6E-5	6E-4
		St wall (7E+3)	-	-	-	1E-8	-	-
		W, see ^{93m} Tc	-	1E+3	5E-7	2E-9	-	-
43	Technetium-97	D, see ^{93m} Tc	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
		W, see ^{93m} Tc	-	6E+3	2E-6	8E-9	-	-
43	Technetium-98	D, see ^{93m} Tc	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ^{93m} Tc	-	3E+2	1E-7	4E-10	-	-
43	Technetium-99m	D, see ^{93m} Tc	8E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, see ^{93m} Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-99	D, see ^{93m} Tc	4E+3	5E+3	2E-6	-	6E-5	6E-4
		St wall (6E+3)	-	-	-	8E-9	-	-
		W, see ^{93m} Tc	-	7E+2	3E-7	9E-10	-	-
43	Technetium-101 ²	D, see ^{93m} Tc	9E+4	3E+5	1E-4	5E-7	-	-
		St wall (1E+5)	-	-	-	-	2E-3	2E-2
		W, see ^{93m} Tc	-	4E+5	2E-4	5E-7	-	-
43	Technetium-104 ²	D, see ^{93m} Tc	2E+4	7E+4	3E-5	1E-7	-	-
		St wall (3E+4)	-	-	-	-	4E-4	4E-3
		W, see ^{93m} Tc	-	9E+4	4E-5	1E-7	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
44	Ruthenium-94 ²	D, all compounds except those given for W and Y	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, halides	-	6E+4	3E-5	9E-8	-	-
		Y, oxides and hydroxides	-	6E+4	2E-5	8E-8	-	-
44	Ruthenium-97	D, see ⁹⁴ Ru	8E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ⁹⁴ Ru	-	1E+4	5E-6	2E-8	-	-
		Y, see ⁹⁴ Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-103	D, see ⁹⁴ Ru	2E+3	2E+3	7E-7	2E-9	3E-5	3E-4
		W, see ⁹⁴ Ru	-	1E+3	4E-7	1E-9	-	-
		Y, see ⁹⁴ Ru	-	6E+2	3E-7	9E-10	-	-
44	Ruthenium-105	D, see ⁹⁴ Ru	5E+3	1E+4	6E-6	2E-8	7E-5	7E-4
		W, see ⁹⁴ Ru	-	1E+4	6E-6	2E-8	-	-
		Y, see ⁹⁴ Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-106	D, see ⁹⁴ Ru	2E+2	9E+1	4E-8	1E-10	-	-
		LLI wall (2E+2)	-	-	-	3E-6	3E-5	
		W, see ⁹⁴ Ru	-	5E+1	2E-8	8E-11	-	-
		Y, see ⁹⁴ Ru	-	1E+1	5E-9	2E-11	-	-
45	Rhodium-99m	D, all compounds except those given for W and Y	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
		W, halides	-	8E+4	3E-5	1E-7	-	-
		Y, oxides and hydroxides	-	7E+4	3E-5	9E-8	-	-
45	Rhodium-99	D, see ^{99m} Rh	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{99m} Rh	-	2E+3	9E-7	3E-9	-	-
		Y, see ^{99m} Rh	-	2E+3	8E-7	3E-9	-	-
45	Rhodium-100	D, see ^{99m} Rh	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
		W, see ^{99m} Rh	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{99m} Rh	-	4E+3	2E-6	5E-9	-	-
45	Rhodium-101m	D, see ^{99m} Rh	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see ^{99m} Rh	-	8E+3	4E-6	1E-8	-	-
		Y, see ^{99m} Rh	-	8E+3	3E-6	1E-8	-	-
45	Rhodium-101	D, see ^{99m} Rh	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ^{99m} Rh	-	8E+2	3E-7	1E-9	-	-
		Y, see ^{99m} Rh	-	2E+2	6E-8	2E-10	-	-
45	Rhodium-102m	D, see ^{99m} Rh	1E+3	5E+2	2E-7	7E-10	-	-
		LLI wall (1E+3)	-	-	-	2E-5	2E-4	
		W, see ^{99m} Rh	-	4E+2	2E-7	5E-10	-	-
		Y, see ^{99m} Rh	-	1E+2	5E-8	2E-10	-	-
45	Rhodium-102	D, see ^{99m} Rh	6E+2	9E+1	4E-8	1E-10	8E-6	8E-5
		W, see ^{99m} Rh	-	2E+2	7E-8	2E-10	-	-
		Y, see ^{99m} Rh	-	6E+1	2E-8	8E-11	-	-
45	Rhodium-103m ²	D, see ^{99m} Rh	4E+5	1E+6	5E-4	2E-6	6E-3	6E-2
		W, see ^{99m} Rh	-	1E+6	5E-4	2E-6	-	-
		Y, see ^{99m} Rh	-	1E+6	5E-4	2E-6	-	-
45	Rhodium-105	D, see ^{99m} Rh	4E+3	1E+4	5E-6	2E-8	-	-
		LLI wall (4E+3)	-	-	-	5E-5	5E-4	
		W, see ^{99m} Rh	-	6E+3	3E-6	9E-9	-	-
		Y, see ^{99m} Rh	-	6E+3	2E-6	8E-9	-	-
45	Rhodium-106m	D, see ^{99m} Rh	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, see ^{99m} Rh	-	4E+4	2E-5	5E-8	-	-
		Y, see ^{99m} Rh	-	4E+4	1E-5	5E-8	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
45	Rhodium-107 ²	D, see ^{99m} Rh	7E+4	2E+5	1E-4	3E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{99m} Rh	-	3E+5	1E-4	4E-7	-	-
46	Palladium-100	Y, see ^{99m} Rh	-	3E+5	1E-4	3E-7	-	-
		D, all compounds except those given for W and Y	1E+3	1E+3	6E-7	2E-9	2E-5	2E-4
		W, nitrates	-	1E+3	5E-7	2E-9	-	-
46	Palladium-101	Y, oxides and hydroxides	-	1E+3	6E-7	2E-9	-	-
		D, see ¹⁰⁰ Pd	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ¹⁰⁰ Pd	-	3E+4	1E-5	5E-8	-	-
46	Palladium-103	Y, see ¹⁰⁰ Pd	-	3E+4	1E-5	4E-8	-	-
		D, see ¹⁰⁰ Pd	6E+3	6E+3	3E-6	9E-9	-	-
			LLI wall (7E+3)	-	-	-	1E-4	1E-3
46	Palladium-107	W, see ¹⁰⁰ Pd	-	4E+3	2E-6	6E-9	-	-
		Y, see ¹⁰⁰ Pd	-	4E+3	1E-6	5E-9	-	-
		D, see ¹⁰⁰ Pd	3E+4	2E+4	9E-6	-	-	-
46	Palladium-109		LLI wall (4E+4)	Kidneys (2E+4)	-	3E-8	5E-4	5E-3
		W, see ¹⁰⁰ Pd	-	7E+3	3E-6	1E-8	-	-
		Y, see ¹⁰⁰ Pd	-	4E+2	2E-7	6E-10	-	-
46	Palladium-109	D, see ¹⁰⁰ Pd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		W, see ¹⁰⁰ Pd	-	5E+3	2E-6	8E-9	-	-
		Y, see ¹⁰⁰ Pd	-	5E+3	2E-6	6E-9	-	-
47	Silver-102 ²	D, all compounds except those given for W and Y	5E+4	2E+5	8E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	9E-4	9E-3
		W, nitrates and sulfides	-	2E+5	9E-5	3E-7	-	-
47	Silver-103 ²	Y, oxides and hydroxides	-	2E+5	8E-5	3E-7	-	-
		D, see ¹⁰² Ag	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ¹⁰² Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104m ²	Y, see ¹⁰² Ag	-	1E+5	5E-5	2E-7	-	-
		D, see ¹⁰² Ag	3E+4	9E+4	4E-5	1E-7	4E-4	4E-3
		W, see ¹⁰² Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104 ²	Y, see ¹⁰² Ag	-	1E+5	5E-5	2E-7	-	-
		D, see ¹⁰² Ag	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ¹⁰² Ag	-	1E+5	6E-5	2E-7	-	-
47	Silver-105	Y, see ¹⁰² Ag	-	1E+5	6E-5	2E-7	-	-
		D, see ¹⁰² Ag	3E+3	1E+3	4E-7	1E-9	4E-5	4E-4
		W, see ¹⁰² Ag	-	2E+3	7E-7	2E-9	-	-
47	Silver-106m	Y, see ¹⁰² Ag	-	2E+3	7E-7	2E-9	-	-
		D, see ¹⁰² Ag	8E+2	7E+2	3E-7	1E-9	1E-5	1E-4
		W, see ¹⁰² Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-106 ²	Y, see ¹⁰² Ag	-	9E+2	4E-7	1E-9	-	-
		D, see ¹⁰² Ag	6E+4	2E+5	8E-5	3E-7	-	-
			St. wall (6E+4)	-	-	-	9E-4	9E-3
47	Silver-108m	W, see ¹⁰² Ag	-	2E+5	9E-5	3E-7	-	-
		Y, see ¹⁰² Ag	-	2E+5	8E-5	3E-7	-	-
		D, see ¹⁰² Ag	6E+2	2E+2	8E-8	3E-10	9E-6	9E-5
47	Silver-108m	W, see ¹⁰² Ag	-	3E+2	1E-7	4E-10	-	-
		Y, see ¹⁰² Ag	-	2E+1	1E-8	3E-11	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers	
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml	
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml		
				ALI μCi	DAC μCi/ml				
47	Silver-110m	D, see ¹⁰² Ag	5E+2	1E+2	5E-8	2E-10	6E-6	6E-5	
		W, see ¹⁰² Ag	-	2E+2	8E-8	3E-10	-	-	
		Y, see ¹⁰² Ag	-	9E+1	4E-8	1E-10	-	-	
47	Silver-111	D, see ¹⁰² Ag	9E+2	2E+3	6E-7	-	-	-	
		LLI wall (1E+3)	-	Liver (2E+3)	-	2E-9	2E-5	2E-4	
		W, see ¹⁰² Ag	-	9E+2	4E-7	1E-9	-	-	
47	Silver-112	Y, see ¹⁰² Ag	-	9E+2	4E-7	1E-9	-	-	
		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	-	-	
47	Silver-115 ²	Y, see ¹⁰² Ag	-	9E+3	4E-6	1E-8	-	-	
		D, see ¹⁰² Ag	3E+4	9E+4	4E-5	1E-7	-	-	
		St wall (3E+4)	-	-	-	-	4E-4	4E-3	
48	Cadmium-104 ²	W, see ¹⁰² Ag	-	9E+4	4E-5	1E-7	-	-	
		Y, see ¹⁰² Ag	-	8E+4	3E-5	1E-7	-	-	
		D, all compounds except those given for W and Y	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3	
48	Cadmium-107	W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-	
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-	
		D, see ¹⁰⁴ Cd	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3	
48	Cadmium-109	W, see ¹⁰⁴ Cd	-	6E+4	2E-5	8E-8	-	-	
		Y, see ¹⁰⁴ Cd	-	5E+4	2E-5	7E-8	-	-	
		D, see ¹⁰⁴ Cd	3E+2	4E+1	1E-8	-	-	-	
48	Cadmium-113m	W, see ¹⁰⁴ Cd	-	Kidneys (4E+2)	Kidneys (5E+1)	-	7E-11	6E-6	6E-5
		Y, see ¹⁰⁴ Cd	-	1E+2	5E-8	-	-	-	
		D, see ¹⁰⁴ Cd	-	Kidneys (1E+2)	-	2E-10	-	-	
48	Cadmium-113	W, see ¹⁰⁴ Cd	-	1E+2	5E-8	2E-10	-	-	
		Y, see ¹⁰⁴ Cd	-	1E+2	5E-8	2E-10	-	-	
		D, see ¹⁰⁴ Cd	2E+1	2E+0	1E-9	-	-	-	
48	Cadmium-115m	W, see ¹⁰⁴ Cd	-	Kidneys (4E+1)	Kidneys (4E+0)	-	5E-12	5E-7	5E-6
		Y, see ¹⁰⁴ Cd	-	8E+0	4E-9	-	-	-	
		D, see ¹⁰⁴ Cd	-	Kidneys (1E+1)	-	2E-11	-	-	
48	Cadmium-115	W, see ¹⁰⁴ Cd	-	1E+1	5E-9	2E-11	-	-	
		Y, see ¹⁰⁴ Cd	-	1E+1	6E-9	2E-11	-	-	
		D, see ¹⁰⁴ Cd	3E+2	5E+1	2E-8	-	4E-6	4E-5	
48	Cadmium-115	W, see ¹⁰⁴ Cd	-	Kidneys (8E+1)	-	1E-10	-	-	
		Y, see ¹⁰⁴ Cd	-	1E+2	5E-8	2E-10	-	-	
		D, see ¹⁰⁴ Cd	-	1E+2	6E-8	2E-10	-	-	
48	Cadmium-115	W, see ¹⁰⁴ Cd	9E+2	1E+3	6E-7	2E-9	-	-	
		LLI wall (1E+3)	-	-	-	-	1E-5	1E-4	
		Y, see ¹⁰⁴ Cd	-	1E+3	6E-7	2E-9	-	-	

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
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	-	-
48	Cadmium-117	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	-	-
49	Indium-109	D, all compounds except those given for W	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	9E-8	-	-
49	Indium-110 ² (69.1 min)	D, see ¹⁰⁹ In	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ¹⁰⁹ In	-	6E+4	2E-5	8E-8	-	-
49	Indium-110 (4.9 h)	D, see ¹⁰⁹ In	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
		W, see ¹⁰⁹ In	-	2E+4	8E-6	3E-8	-	-
49	Indium-111	D, see ¹⁰⁹ In	4E+3	6E+3	3E-6	9E-9	6E-5	6E-4
		W, see ¹⁰⁹ In	-	6E+3	3E-6	9E-9	-	-
49	Indium-112 ²	D, see ¹⁰⁹ In	2E+5	6E+5	3E-4	9E-7	2E-3	2E-2
		W, see ¹⁰⁹ In	-	7E+5	3E-4	1E-6	-	-
49	Indium-113m ²	D, see ¹⁰⁹ In	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		W, see ¹⁰⁹ In	-	2E+5	8E-5	3E-7	-	-
49	Indium-114m	D, see ¹⁰⁹ In	3E+2	6E+1	3E-8	9E-11	-	-
		LLI wall (4E+2)	-	-	-	-	5E-6	5E-5
		W, see ¹⁰⁹ In	-	1E+2	4E-8	1E-10	-	-
49	Indium-115m	D, see ¹⁰⁹ In	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ¹⁰⁹ In	-	5E+4	2E-5	7E-8	-	-
49	Indium-115	D, see ¹⁰⁹ In	4E+1	1E+0	6E-10	2E-12	5E-7	5E-6
		W, see ¹⁰⁹ In	-	5E+0	2E-9	8E-12	-	-
49	Indium-116m ²	D, see ¹⁰⁹ In	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		W, see ¹⁰⁹ In	-	1E+5	5E-5	2E-7	-	-
49	Indium-117m ²	D, see ¹⁰⁹ In	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ¹⁰⁹ In	-	4E+4	2E-5	6E-8	-	-
49	Indium-117 ²	D, see ¹⁰⁹ In	6E+4	2E+5	7E-5	2E-7	8E-4	8E-3
		W, see ¹⁰⁹ In	-	2E+5	9E-5	3E-7	-	-
49	Indium-119m ²	D, see ¹⁰⁹ In	4E+4	1E+5	5E-5	2E-7	-	-
		St wall (5E+4)	-	-	-	-	7E-4	7E-3
		W, see ¹⁰⁹ In	-	1E+5	6E-5	2E-7	-	-
50	Tin-110	D, all compounds except those given for W	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
		W, sulfides, oxides, hydroxides, halides, nitrates, and stannic phosphate	-	1E+4	5E-6	2E-8	-	-
50	Tin-111 ²	D, see ¹¹⁰ Sn	7E+4	2E+5	9E-5	3E-7	1E-3	1E-2
		W, see ¹¹⁰ Sn	-	3E+5	1E-4	4E-7	-	-
50	Tin-113	D, see ¹¹⁰ Sn	2E+3	1E+3	5E-7	2E-9	-	-
		LLI wall (2E+3)	-	-	-	-	3E-5	3E-4
		W, see ¹¹⁰ Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-117m	D, see ¹¹⁰ Sn	2E+3	1E+3	5E-7	-	-	-
		LLI wall (2E+3)	-	Bone surf (2E+3)	-	3E-9	3E-5	3E-4
		W, see ¹¹⁰ Sn	-	1E+3	6E-7	2E-9	-	-
50	Tin-119m	D, see ¹¹⁰ Sn	3E+3	2E+3	1E-6	3E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
			LLI wall (4E+3)	-	-	-	6E-5	6E-4
50	Tin-121m	W, see ¹¹⁰ Sn	-	1E+3	4E-7	1E-9	-	-
		D, see ¹¹⁰ Sn	3E+3	9E+2	4E-7	1E-9	-	-
			LLI wall (4E+3)	-	-	-	5E-5	5E-4
50	Tin-121	W, see ¹¹⁰ Sn	-	5E+2	2E-7	8E-10	-	-
		D, see ¹¹⁰ Sn	6E+3	2E+4	6E-6	2E-8	-	-
			LLI wall (6E+3)	-	-	-	8E-5	8E-4
50	Tin-123m ²	W, see ¹¹⁰ Sn	-	1E+4	5E-6	2E-8	-	-
		D, see ¹¹⁰ Sn	5E+4	1E+5	5E-5	2E-7	7E-4	7E-3
50	Tin-123	W, see ¹¹⁰ Sn	-	1E+5	6E-5	2E-7	-	-
		D, see ¹¹⁰ Sn	5E+2	6E+2	3E-7	9E-10	-	-
			LLI wall (6E+2)	-	-	-	9E-6	9E-5
50	Tin-125	W, see ¹¹⁰ Sn	-	2E+2	7E-8	2E-10	-	-
		D, see ¹¹⁰ Sn	4E+2	9E+2	4E-7	1E-9	-	-
			LLI wall (5E+2)	-	-	-	6E-6	6E-5
50	Tin-126	W, see ¹¹⁰ Sn	-	4E+2	1E-7	5E-10	-	-
		D, see ¹¹⁰ Sn	3E+2	6E+1	2E-8	8E-11	4E-6	4E-5
50	Tin-127	W, see ¹¹⁰ Sn	-	7E+1	3E-8	9E-11	-	-
		D, see ¹¹⁰ Sn	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
50	Tin-128 ²	W, see ¹¹⁰ Sn	-	2E+4	8E-6	3E-8	-	-
		D, see ¹¹⁰ Sn	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
51	Antimony-115 ²	W, see ¹¹⁰ Sn	-	4E+4	1E-5	5E-8	-	-
		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
51	Antimony-116 ²	W, see ¹¹⁵ Sb	-	1E+5	6E-5	2E-7	-	-
		D, see ¹¹⁵ Sb	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
51	Antimony-117	W, see ¹¹⁵ Sb	-	3E+5	1E-4	5E-7	-	-
		D, see ¹¹⁵ Sb	7E+4	2E+5	9E-5	3E-7	9E-4	9E-3
51	Antimony-118m	W, see ¹¹⁵ Sb	-	3E+5	1E-4	4E-7	-	-
		D, see ¹¹⁵ Sb	6E+3	2E+4	8E-6	3E-8	7E-5	7E-4
51	Antimony-119	W, see ¹¹⁵ Sb	5E+3	2E+4	9E-6	3E-8	-	-
		D, see ¹¹⁵ Sb	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
51	Antimony-120 ² (16 min)	W, see ¹¹⁵ Sb	2E+4	3E+4	1E-5	4E-8	-	-
		D, see ¹¹⁵ Sb	1E+5	4E+5	2E-4	6E-7	-	-
			St wall (2E+5)	-	-	-	2E-3	2E-2
51	Antimony-120 (5.76 d)	W, see ¹¹⁵ Sb	-	5E+5	2E-4	7E-7	-	-
		D, see ¹¹⁵ Sb	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
51	Antimony-122	W, see ¹¹⁵ Sb	9E+2	1E+3	5E-7	2E-9	-	-
		D, see ¹¹⁵ Sb	8E+2	2E+3	1E-6	3E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
		W, see ¹¹⁵ Sb	7E+2	1E+3	4E-7	2E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
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	2E+5	8E-5	3E-7	-	-
		St wall (7E+4)	-	-	-	-	9E-4	9E-3
51	Antimony-126	W, see ¹¹⁵ Sb	-	2E+5	8E-5	3E-7	-	-
		D, see ¹¹⁵ Sb	6E+2	1E+3	5E-7	2E-9	7E-6	7E-5
51	Antimony-127	W, see ¹¹⁵ Sb	5E+2	5E+2	2E-7	7E-10	-	-
		D, see ¹¹⁵ Sb	8E+2	2E+3	9E-7	3E-9	-	-
51	Antimony-128 ² (10.4 min)	LLI wall (8E+2)	-	-	-	-	1E-5	1E-4
		W, see ¹¹⁵ Sb	7E+2	9E+2	4E-7	1E-9	-	-
51	Antimony-128 ² (9.01 h)	D, see ¹¹⁵ Sb	8E+4	4E+5	2E-4	5E-7	-	-
		St wall (1E+5)	-	-	-	-	1E-3	1E-2
51	Antimony-129	W, see ¹¹⁵ Sb	-	4E+5	2E-4	6E-7	-	-
		D, see ¹¹⁵ Sb	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
51	Antimony-130 ²	W, see ¹¹⁵ Sb	-	3E+3	1E-6	5E-9	-	-
		D, see ¹¹⁵ Sb	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
51	Antimony-131 ²	W, see ¹¹⁵ Sb	-	9E+3	4E-6	1E-8	-	-
		D, see ¹¹⁵ Sb	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
51	Antimony-131 ²	W, see ¹¹⁵ Sb	-	8E+4	3E-5	1E-7	-	-
		D, see ¹¹⁵ Sb	1E+4	2E+4	1E-5	-	-	-
52	Tellurium-116	Thyroid (2E+4)	-	Thyroid (4E+4)	-	6E-8	2E-4	2E-3
		W, see ¹¹⁵ Sb	-	2E+4	1E-5	-	-	-
52	Tellurium-116	D, all compounds except those given for W	-	Thyroid (4E+4)	-	6E-8	-	-
		W, oxides, hydroxides, and nitrates	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
52	Tellurium-121m	D, see ¹¹⁶ Te	-	3E+4	1E-5	4E-8	-	-
		W, see ¹¹⁶ Te	5E+2	2E+2	8E-8	-	-	-
52	Tellurium-121	D, see ¹¹⁶ Te	Bone surf (7E+2)	Bone surf (4E+2)	-	5E-10	1E-5	1E-4
		W, see ¹¹⁶ Te	-	4E+2	2E-7	6E-10	-	-
52	Tellurium-123m	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-123	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-125m	D, see ¹¹⁶ Te	-	Bone surf (1E+3)	-	2E-9	-	-
		W, see ¹¹⁶ Te	1E+3	4E+2	2E-7	-	-	-
52	Tellurium-125m	D, see ¹¹⁶ Te	Bone surf (1E+3)	Bone surf (1E+3)	-	1E-9	2E-5	2E-4
		W, see ¹¹⁶ Te	-	Bone surf (1E+3)	-	2E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
52	Tellurium-127m	W, see ¹¹⁶ Te	-	7E+2	3E-7	1E-9	-	-
		D, see ¹¹⁶ Te	6E+2	3E+2	1E-7	-	9E-6	9E-5
52	Tellurium-127	W, see ¹¹⁶ Te	-	Bone surf (4E+2)	-	6E-10	-	-
		D, see ¹¹⁶ Te	7E+3	3E+2	1E-7	4E-10	-	-
52	Tellurium-129m	W, see ¹¹⁶ Te	-	2E+4	7E-6	2E-8	-	-
		D, see ¹¹⁶ Te	5E+2	6E+2	3E-7	9E-10	7E-6	7E-5
52	Tellurium-129 ²	W, see ¹¹⁶ Te	-	2E+2	1E-7	3E-10	-	-
		D, see ¹¹⁶ Te	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
52	Tellurium-131m	W, see ¹¹⁶ Te	-	7E+4	3E-5	1E-7	-	-
		D, see ¹¹⁶ Te	3E+2	4E+2	2E-7	-	-	-
52	Tellurium-131 ²	Thyroid (6E+2)	-	Thyroid (1E+3)	-	2E-9	8E-6	8E-5
		W, see ¹¹⁶ Te	-	4E+2	2E-7	-	-	-
52	Tellurium-131 ²	D, see ¹¹⁶ Te	3E+3	Thyroid (9E+2)	-	1E-9	-	-
		W, see ¹¹⁶ Te	-	Thyroid (6E+3)	-	2E-8	8E-5	8E-4
52	Tellurium-132	D, see ¹¹⁶ Te	-	5E+3	2E-6	-	-	-
		W, see ¹¹⁶ Te	-	Thyroid (1E+4)	-	2E-8	-	-
52	Tellurium-132	D, see ¹¹⁶ Te	2E+2	2E+2	9E-8	-	-	-
		W, see ¹¹⁶ Te	-	Thyroid (7E+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-133 ²	D, see ¹¹⁶ Te	3E+3	5E+3	2E-6	-	-	-
		W, see ¹¹⁶ Te	-	Thyroid (1E+4)	-	2E-8	9E-5	9E-4
52	Tellurium-133 ²	D, see ¹¹⁶ Te	-	Thyroid (1E+4)	-	2E-8	-	-
		W, see ¹¹⁶ Te	1E+4	2E+4	9E-6	-	-	-
52	Tellurium-134 ²	D, see ¹¹⁶ Te	Thyroid (3E+4)	Thyroid (6E+4)	-	8E-8	4E-4	4E-3
		W, see ¹¹⁶ Te	-	2E+4	9E-6	-	-	-
52	Tellurium-134 ²	D, see ¹¹⁶ Te	-	Thyroid (6E+4)	-	8E-8	-	-
		W, see ¹¹⁶ Te	2E+4	2E+4	1E-5	-	-	-
53	Iodine-120m ²	D, all compounds	Thyroid (2E+4)	Thyroid (5E+4)	-	7E-8	3E-4	3E-3
		W, see ¹¹⁶ Te	-	2E+4	1E-5	-	-	-
53	Iodine-120 ²	D, all compounds	-	Thyroid (5E+4)	-	7E-8	-	-
		W, see ¹¹⁶ Te	1E+4	2E+4	9E-6	3E-8	-	-
53	Iodine-121	D, all compounds	Thyroid (1E+4)	-	-	-	2E-4	2E-3
		W, see ¹¹⁶ Te	4E+3	9E+3	4E-6	-	-	-
53	Iodine-123	D, all compounds	Thyroid (8E+3)	Thyroid (1E+4)	-	2E-8	1E-4	1E-3
		W, see ¹¹⁶ Te	1E+4	2E+4	8E-6	-	-	-
53	Iodine-123	D, all compounds	Thyroid (3E+4)	Thyroid (5E+4)	-	7E-8	4E-4	4E-3
		W, see ¹¹⁶ Te	3E+3	6E+3	3E-6	-	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
53	Iodine-124	D, all compounds	Thyroid (1E+4)	Thyroid (2E+4)	-	2E-8	1E-4	1E-3
			5E+1	8E+1	3E-8	-	-	-
53	Iodine-125	D, all compounds	Thyroid (2E+2)	Thyroid (3E+2)	-	4E-10	2E-6	2E-5
			4E+1	6E+1	3E-8	-	-	-
53	Iodine-126	D, all compounds	Thyroid (1E+2)	Thyroid (2E+2)	-	3E-10	2E-6	2E-5
			2E+1	4E+1	1E-8	-	-	-
53	Iodine-128 ²	D, all compounds	Thyroid (7E+1)	Thyroid (1E+2)	-	2E-10	1E-6	1E-5
			4E+4	1E+5	5E-5	2E-7	-	-
53	Iodine-129	D, all compounds	St wall (6E+4)	-	-	-	8E-4	8E-3
			5E+0	9E+0	4E-9	-	-	-
53	Iodine-130	D, all compounds	Thyroid (2E+1)	Thyroid (3E+1)	-	4E-11	2E-7	2E-6
			4E+2	7E+2	3E-7	-	-	-
53	Iodine-131	D, all compounds	Thyroid (1E+3)	Thyroid (2E+3)	-	3E-9	2E-5	2E-4
			3E+1	5E+1	2E-8	-	-	-
53	Iodine-132m ²	D, all compounds	Thyroid (9E+1)	Thyroid (2E+2)	-	2E-10	1E-6	1E-5
			4E+3	8E+3	4E-6	-	-	-
53	Iodine-132	D, all compounds	Thyroid (1E+4)	Thyroid (2E+4)	-	3E-8	1E-4	1E-3
			4E+3	8E+3	3E-6	-	-	-
53	Iodine-133	D, all compounds	Thyroid (9E+3)	Thyroid (1E+4)	-	2E-8	1E-4	1E-3
			1E+2	3E+2	1E-7	-	-	-
53	Iodine-134 ²	D, all compounds	Thyroid (5E+2)	Thyroid (9E+2)	-	1E-9	7E-6	7E-5
			2E+4	5E+4	2E-5	6E-8	-	-
53	Iodine-135	D, all compounds	Thyroid (3E+4)	-	-	-	4E-4	4E-3
			8E+2	2E+3	7E-7	-	-	-
54	Xenon-120 ²	Submersion ¹	Thyroid (3E+3)	Thyroid (4E+3)	-	6E-9	3E-5	3E-4
			-	-	-	6E-9	3E-5	3E-4
54	Xenon-121 ²	Submersion ¹	-	-	1E-5	4E-8	-	-
54	Xenon-122	Submersion ¹	-	-	2E-6	1E-8	-	-
54	Xenon-123	Submersion ¹	-	-	7E-5	3E-7	-	-
54	Xenon-125	Submersion ¹	-	-	6E-6	3E-8	-	-
54	Xenon-127	Submersion ¹	-	-	2E-5	7E-8	-	-
54	Xenon-129m	Submersion ¹	-	-	1E-5	6E-8	-	-
54	Xenon-131m	Submersion ¹	-	-	2E-4	9E-7	-	-
54	Xenon-133m	Submersion ¹	-	-	4E-4	2E-6	-	-
54	Xenon-133	Submersion ¹	-	-	1E-4	6E-7	-	-
54	Xenon-135m ²	Submersion ¹	-	-	1E-4	5E-7	-	-
54	Xenon-135	Submersion ¹	-	-	9E-6	4E-8	-	-
54	Xenon-138 ²	Submersion ¹	-	-	1E-5	7E-8	-	-
55	Cesium-125 ²	D, all compounds	-	-	4E-6	2E-8	-	-
55	Cesium-127	D, all compounds	St wall (9E+4)	-	-	-	1E-3	1E-2
			5E+4	1E+5	6E-5	2E-7	-	-
55	Cesium-129	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

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
55	Cesium-130 ²	D, all compounds	6E+4	2E+5	8E-5	3E-7	-	-
			St wall (1E+5)	-	-	-	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	1E+5	6E-5	2E-7	-	-
			St wall (1E+5)	-	-	-	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
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	6E+4	2E-5	8E-8	-	-
			St wall (3E+4)	-	-	-	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	1E+6	6E-4	2E-6	-	-
			St wall (5E+5)	-	-	-	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	9E+3	4E-6	1E-8	-	-
			LLI wall (3E+3)	-	-	-	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	1E+3	6E-7	2E-9	-	-
			LLI wall (6E+2)	-	-	-	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	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		W, oxides and hydroxides	-	2E+5	7E-5	2E-7	-	-
57	Lanthanum-132	D, see ¹³¹ La	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
		W, see ¹³¹ La	-	1E+4	5E-6	2E-8	-	-
57	Lanthanum-135	D, see ¹³¹ La	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ¹³¹ La	-	9E+4	4E-5	1E-7	-	-
57	Lanthanum-137	D, see ¹³¹ La	1E+4	6E+1	3E-8	-	2E-4	2E-3
			-	Liver (7E+1)	-	1E-10	-	-
		W, see ¹³¹ La	-	3E+2	1E-7	-	-	-
			-	Liver (3E+2)	-	4E-10	-	-
57	Lanthanum-138	D, see ¹³¹ La	9E+2	4E+0	1E-9	5E-12	1E-5	1E-4
		W, see ¹³¹ La	-	1E+1	6E-9	2E-11	-	-
57	Lanthanum-140	D, see ¹³¹ La	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ¹³¹ La	-	1E+3	5E-7	2E-9	-	-
57	Lanthanum-141	D, see ¹³¹ La	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		W, see ¹³¹ La	-	1E+4	5E-6	2E-8	-	-
57	Lanthanum-142 ²	D, see ¹³¹ La	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ¹³¹ La	-	3E+4	1E-5	5E-8	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
57	Lanthanum-143 ²	D, see ¹³¹ La	4E+4	1E+5	4E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
58	Cerium-134	W, see ¹³¹ La	-	9E+4	4E-5	1E-7	-	-
		W, all compounds except those given for Y	5E+2	7E+2	3E-7	1E-9	-	-
58	Cerium-135	Y, oxides, hydroxides, and fluorides	LLI wall (6E+2)	-	-	-	8E-6	8E-5
		W, see ¹³⁴ Ce	-	7E+2	3E-7	9E-10	-	-
58	Cerium-137m	Y, see ¹³⁴ Ce	2E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ¹³⁴ Ce	-	4E+3	1E-6	5E-9	-	-
58	Cerium-137	W, see ¹³⁴ Ce	2E+3	4E+3	2E-6	6E-9	-	-
		Y, see ¹³⁴ Ce	LLI wall (2E+3)	-	-	-	3E-5	3E-4
58	Cerium-139	W, see ¹³⁴ Ce	-	4E+3	2E-6	5E-9	-	-
		Y, see ¹³⁴ Ce	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
58	Cerium-141	W, see ¹³⁴ Ce	-	1E+5	5E-5	2E-7	-	-
		Y, see ¹³⁴ Ce	5E+3	8E+2	3E-7	1E-9	7E-5	7E-4
58	Cerium-143	W, see ¹³⁴ Ce	-	7E+2	3E-7	9E-10	-	-
		Y, see ¹³⁴ Ce	2E+3	7E+2	3E-7	1E-9	-	-
58	Cerium-144	W, see ¹³⁴ Ce	LLI wall (2E+3)	-	-	-	3E-5	3E-4
		Y, see ¹³⁴ Ce	-	6E+2	2E-7	8E-10	-	-
58	Praseodymium-136 ²	W, see ¹³⁴ Ce	1E+3	2E+3	8E-7	3E-9	-	-
		Y, see ¹³⁴ Ce	LLI wall (1E+3)	-	-	-	2E-5	2E-4
58	Praseodymium-137 ²	W, see ¹³⁴ Ce	-	2E+3	7E-7	2E-9	-	-
		Y, see ¹³⁴ Ce	2E+2	3E+1	1E-8	4E-11	-	-
59	Praseodymium-138m	W, see ¹³⁴ Ce	LLI wall (3E+2)	-	-	-	3E-6	3E-5
		Y, see ¹³⁴ Ce	-	1E+1	6E-9	2E-11	-	-
59	Praseodymium-139	W, all compounds except those given for Y	5E+4	2E+5	1E-4	3E-7	-	-
		Y, oxides, hydroxides, carbides, and fluorides	St wall (7E+4)	-	-	-	1E-3	1E-2
59	Praseodymium-142m ²	W, see ¹³⁶ Pr	4E+4	2E+5	9E-5	3E-7	-	-
		Y, see ¹³⁶ Pr	-	2E+5	6E-5	2E-7	5E-4	5E-3
59	Praseodymium-142	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-143	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-144 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-143	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-144 ²	W, see ¹³⁶ Pr	9E+2	8E+2	3E-7	1E-9	-	-
		Y, see ¹³⁶ Pr	LLI wall (1E+3)	-	-	-	2E-5	2E-4
59	Praseodymium-144 ²	W, see ¹³⁶ Pr	-	7E+2	3E-7	9E-10	-	-
		Y, see ¹³⁶ Pr	3E+4	1E+5	5E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
59	Praseodymium-145	Y, see ¹³⁶ Pr	-	1E+5	5E-5	2E-7	-	-
		W, see ¹³⁶ Pr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
59	Praseodymium-147 ²	Y, see ¹³⁶ Pr	-	8E+3	3E-6	1E-8	-	-
		W, see ¹³⁶ Pr	5E+4	2E+5	8E-5	3E-7	-	-
60	Neodymium-136 ²	St wall (8E+4)	-	-	-	-	1E-3	1E-2
		Y, see ¹³⁶ Pr	-	2E+5	8E-5	3E-7	-	-
60	Neodymium-138	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-139m	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-139 ²	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-141	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-147	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-149 ²	W, see ¹³⁶ Nd	1E+3	9E+2	4E-7	1E-9	-	-
		Y, see ¹³⁶ Nd	-	8E+2	4E-7	1E-9	-	-
60	Neodymium-151 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	-	-
61	Promethium-141 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-143	W, all compounds except those given for Y	5E+4	2E+5	8E-5	3E-7	-	-
		Y, oxides, hydroxides, carbides, and fluorides	St wall (6E+4)	-	-	-	-	8E-4
61	Promethium-144	W, see ¹⁴¹ Pm	-	2E+5	7E-5	2E-7	-	-
		Y, see ¹⁴¹ Pm	5E+3	6E+2	2E-7	8E-10	7E-5	7E-4
61	Promethium-145	W, see ¹⁴¹ Pm	-	7E+2	3E-7	1E-9	-	-
		Y, see ¹⁴¹ Pm	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
61	Promethium-146	W, see ¹⁴¹ Pm	-	1E+2	5E-8	2E-10	-	-
		Y, see ¹⁴¹ Pm	1E+4	2E+2	7E-8	-	1E-4	1E-3
61	Promethium-147	Bone surf (2E+2)	-	2E+2	8E-8	3E-10	-	-
		W, see ¹⁴¹ Pm	2E+3	5E+1	2E-8	7E-11	2E-5	2E-4
61	Promethium-148m	Y, see ¹⁴¹ Pm	-	4E+1	2E-8	6E-11	-	-
		W, see ¹⁴¹ Pm	4E+3	1E+2	5E-8	-	-	-
61	Promethium-148	LLI wall (5E+3)	LLI wall (5E+3)	Bone surf (2E+2)	-	3E-10	7E-5	7E-4
		Y, see ¹⁴¹ Pm	-	1E+2	6E-8	2E-10	-	-
61	Promethium-149	W, see ¹⁴¹ Pm	7E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		Y, see ¹⁴¹ Pm	-	3E+2	1E-7	5E-10	-	-
61	Promethium-149	W, see ¹⁴¹ Pm	4E+2	5E+2	2E-7	8E-10	-	-
		Y, see ¹⁴¹ Pm	LLI wall (5E+2)	-	-	-	7E-6	7E-5
61	Promethium-149	W, see ¹⁴¹ Pm	-	5E+2	2E-7	7E-10	-	-
		Y, see ¹⁴¹ Pm	1E+3	2E+3	8E-7	3E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
61	Promethium-150	Y, see ¹⁴¹ Pm	-	2E+3	8E-7	2E-9	-	-
		W, see ¹⁴¹ Pm	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
61	Promethium-151	Y, see ¹⁴¹ Pm	-	2E+4	7E-6	2E-8	-	-
		W, see ¹⁴¹ Pm	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ¹⁴¹ Pm	-	3E+3	1E-6	4E-9	-	-
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	2E+5	8E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
62	Samarium-142 ²	W, all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
62	Samarium-145	W, all compounds	6E+3	5E+2	2E-7	7E-10	8E-5	8E-4
62	Samarium-146	W, all compounds	1E+1	4E-2	1E-11	-	-	-
			Bone surf (3E+1)	Bone surf (6E-2)	-	9E-14	3E-7	3E-6
62	Samarium-147	W, all compounds	2E+1	4E-2	2E-11	-	-	-
			Bone surf (3E+1)	Bone surf (7E-2)	-	1E-13	4E-7	4E-6
62	Samarium-151	W, all compounds	1E+4	1E+2	4E-8	-	-	-
			LLI wall (1E+4)	Bone surf (2E+2)	-	2E-10	2E-4	2E-3
62	Samarium-153	W, all compounds	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
62	Samarium-155 ²	W, all compounds	6E+4	2E+5	9E-5	3E-7	-	-
			St wall (8E+4)	-	-	-	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 (12.62h)	W, all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
63	Europium-150 (34.2 y)	W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
63	Europium-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	4E-8	-	5E-5	5E-4
			-	Bone surf (1E+2)	-	2E-10	-	-
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	2E+5	6E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	6E-4	6E-3
		W, oxides, hydroxides, and fluorides	-	2E+5	7E-5	2E-7	-	-
64	Gadolinium-146	D, see ¹⁴⁵ Gd	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		W, see ¹⁴⁵ Gd	-	3E+2	1E-7	4E-10	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
64	Gadolinium-147	D, see ¹⁴⁵ Gd	2E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		W, see ¹⁴⁵ Gd	-	4E+3	1E-6	5E-9	-	-
64	Gadolinium-148	D, see ¹⁴⁵ Gd	1E+1	8E+3	3E-12	-	-	-
			Bone surf (2E+1)	Bone surf (2E+2)	-	2E-14	3E-7	3E-6
		W, see ¹⁴⁵ Gd	-	3E-2	1E-11	-	-	-
			-	Bone surf (6E-2)	-	8E-14	-	-
64	Gadolinium-149	D, see ¹⁴⁵ Gd	3E+3	2E+3	9E-7	3E-9	4E-5	4E-4
		W, see ¹⁴⁵ Gd	-	2E+3	1E-6	3E-9	-	-
64	Gadolinium-151	D, see ¹⁴⁵ Gd	6E+3	4E+2	2E-7	-	9E-5	9E-4
			-	Bone surf (6E+2)	-	9E-10	-	-
		W, see ¹⁴⁵ Gd	-	1E+3	5E-7	2E-9	-	-
64	Gadolinium-152	D, see ¹⁴⁵ Gd	2E+1	1E-2	4E-12	-	-	-
			Bone surf (3E+1)	Bone surf (2E-2)	-	3E-14	4E-7	4E-6
		W, see ¹⁴⁵ Gd	-	4E-2	2E-11	-	-	-
			-	Bone surf (8E-2)	-	1E-13	-	-
64	Gadolinium-153	D, see ¹⁴⁵ Gd	5E+3	1E+2	6E-8	-	6E-5	6E-4
			-	Bone surf (2E+2)	-	3E-10	-	-
		W, see ¹⁴⁵ Gd	-	6E+2	2E-7	8E-10	-	-
64	Gadolinium-159	D, see ¹⁴⁵ Gd	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ¹⁴⁵ Gd	-	6E+3	2E-6	8E-9	-	-
65	Terbium-147 ²	W, all compounds	9E+3	3E+4	1E-5	5E-8	1E-4	1E-3
65	Terbium-149	W, all compounds	5E+3	7E+2	3E-7	1E-9	7E-5	7E-4
65	Terbium-150	W, all compounds	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	3E+2	1E-7	-	-	-
			LLI wall (5E+4)	Bone surf (6E+2)	-	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	2E+3	7E-7	2E-9	-	-
			LLI wall (2E+3)	-	-	-	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	7E+2	3E-7	1E-9	-	-
			LLI wall (8E+2)	-	-	-	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

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
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	2E+6	1E-3	3E-6	-	-
			St wall (8E+5)	-	-	-	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	6E+5	3E-4	9E-7	-	-
			St wall (2E+5)	-	-	-	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	-	-
			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	3E+3	1E-6	4E-9	-	-
			LLI wall (4E+3)	-	-	-	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	1E+3	6E-7	2E-9	-	-
			LLI wall (E+3)	-	-	-	2E-5	2E-4
69	Thulium-162 ²	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (7E+4)	-	-	-	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	2E+3	8E-7	3E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
69	Thulium-170	W, all compounds	8E+2	2E+2	9E-8	3E-10	-	-
			LLI wall (1E+3)	-	-	-	1E-5	1E-4
69	Thulium-171	W, all compounds	1E+4	3E+2	1E-7	-	-	-
			LLI wall (1E+4)	Bone surf (6E+2)	-	8E-10	2E-4	2E-3
69	Thulium-172	W, all compounds	7E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (8E+2)	-	-	-	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	3E+5	1E-4	4E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
70	Ytterbium-162 ²	W, all compounds except those given for Y	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
		Y, oxides, hydroxides, and fluorides	-	3E+5	1E-4	4E-7	-	-
70	Ytterbium-166	W, see ¹⁶² Yb	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		Y, see ¹⁶² Yb	-	2E+3	8E-7	3E-9	-	-
70	Ytterbium-167 ²	W, see ¹⁶² Yb	3E+5	8E+5	3E-4	1E-6	4E-3	4E-2
		Y, see ¹⁶² Yb	-	7E+5	3E-4	1E-6	-	-
70	Ytterbium-169	W, see ¹⁶² Yb	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
		Y, see ¹⁶² Yb	-	7E+2	3E-7	1E-9	-	-
70	Ytterbium-175	W, see ¹⁶² Yb	3E+3	4E+3	1E-6	5E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
70	Ytterbium-177 ²	Y, see ¹⁶² Yb W, see ¹⁶² Yb	- 2E+4	3E+3 5E+4	1E-6 2E-5	5E-9 7E-8	- 2E-4	- 2E-3
70	Ytterbium-178 ²	Y, see ¹⁶² Yb W, see ¹⁶² Yb	- 1E+4	5E+4 4E+4	2E-5 2E-5	6E-8 6E-8	- 2E-4	- 2E-3
71	Lutetium-169	Y, see ¹⁶² Yb W, all compounds except those given for Y	- 3E+3	4E+4 4E+3	2E-5 2E-6	5E-8 6E-9	- 3E-5	- 3E-4
71	Lutetium-170	Y, oxides, hydroxides, and fluorides W, see ¹⁶⁹ Lu	- 1E+3	4E+3 2E+3	2E-6 9E-7	6E-9 3E-9	- 2E-5	- 2E-4
71	Lutetium-171	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 2E+3	2E+3 2E+3	8E-7 8E-7	3E-9 3E-9	- 3E-5	- 3E-4
71	Lutetium-172	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 1E+3	2E+3 1E+3	8E-7 5E-7	3E-9 2E-9	- 1E-5	- 1E-4
71	Lutetium-173	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 5E+3	2E+3 3E+2	8E-7 1E-7	3E-9 -	- 7E-5	- 7E-4
71	Lutetium-174m	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 2E+3	Bone surf (5E+2) 3E+2	- 1E-7	6E-10 4E-10	- -	- -
71	Lutetium-174	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 5E+3	LLI wall (3E+3) 2E+2	- 9E-8	5E-10 3E-10	4E-5 -	4E-4 -
71	Lutetium-176m	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 8E+3	Bone surf (2E+2) 3E+4	- 1E-5	3E-10 3E-8	- 1E-4	- 1E-3
71	Lutetium-176	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 7E+2	2E+2 5E+0	6E-8 2E-9	2E-10 -	- 1E-5	- 1E-4
71	Lutetium-177m	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 7E+2	Bone surf (1E+1) 8E+0	- 3E-9	2E-11 1E-11	- 1E-5	- 1E-4
71	Lutetium-177	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 2E+3	Bone surf (1E+2) 8E+1	- 3E-8	2E-10 1E-10	- -	- -
71	Lutetium-178m ²	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 5E+4	LLI wall (3E+3) 2E+3	- 9E-7	- 3E-9	4E-5 -	4E-4 -
71	Lutetium-178 ²	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 4E+4	St. wall (6E+4) 2E+5	- 8E-5	- 3E-7	8E-4 -	8E-3 -
71	Lutetium-179	Y, see ¹⁶⁹ Lu W, see ¹⁶⁹ Lu	- 6E+3	St wall (4E+4) 1E+5	- 5E-5	- 2E-7	6E-4 -	6E-3 -
72	Hafnium-170	Y, see ¹⁶⁹ Lu D, all compounds except those given for W	- 3E+3	6E+3 6E+3	5E-5 2E-6	2E-7 8E-9	- 4E-5	- 4E-4

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
72	Hafnium-172	W, oxides, hydroxides, carbides, and nitrates	-	5E+3	2E-6	6E-9	-	-
		D, see ¹⁷⁰ Hf	1E+3	9E+0	4E-9	-	2E-5	2E-4
		W, see ¹⁷⁰ Hf	-	Bone surf (2E+1)	-	3E-11	-	-
72	Hafnium-173	D, see ¹⁷⁰ Hf	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ¹⁷⁰ Hf	-	1E+4	5E-6	2E-8	-	-
		D, see ¹⁷⁰ Hf	3E+3	9E+2	4E-7	-	4E-5	4E-4
72	Hafnium-175	D, see ¹⁷⁰ Hf	3E+3	9E+2	4E-7	-	4E-5	4E-4
		W, see ¹⁷⁰ Hf	-	Bone surf (1E+3)	-	1E-9	-	-
		D, see ¹⁷⁰ Hf	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
72	Hafnium-177m ³	D, see ¹⁷⁰ Hf	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		W, see ¹⁷⁰ Hf	-	9E+4	4E-5	1E-7	-	-
		D, see ¹⁷⁰ Hf	3E+2	1E+0	5E-10	-	3E-6	3E-5
72	Hafnium-178m	D, see ¹⁷⁰ Hf	3E+2	1E+0	5E-10	-	3E-6	3E-5
		W, see ¹⁷⁰ Hf	-	Bone surf (2E+0)	-	3E-12	-	-
		D, see ¹⁷⁰ Hf	1E+3	3E+2	1E-7	-	1E-5	1E-4
72	Hafnium-179m	D, see ¹⁷⁰ Hf	1E+3	3E+2	1E-7	-	1E-5	1E-4
		W, see ¹⁷⁰ Hf	-	Bone surf (6E+2)	-	8E-10	-	-
		D, see ¹⁷⁰ Hf	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
72	Hafnium-180m	D, see ¹⁷⁰ Hf	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ¹⁷⁰ Hf	-	3E+4	1E-5	4E-8	-	-
		D, see ¹⁷⁰ Hf	1E+3	2E+2	7E-8	-	2E-5	2E-4
72	Hafnium-181	D, see ¹⁷⁰ Hf	1E+3	2E+2	7E-8	-	2E-5	2E-4
		W, see ¹⁷⁰ Hf	-	Bone surf (4E+2)	-	6E-10	-	-
		D, see ¹⁷⁰ Hf	4E+4	9E+4	4E-5	1E-7	5E-4	5E-3
72	Hafnium-182m ³	D, see ¹⁷⁰ Hf	4E+4	9E+4	4E-5	1E-7	5E-4	5E-3
		W, see ¹⁷⁰ Hf	-	1E+5	6E-5	2E-7	-	-
		D, see ¹⁷⁰ Hf	2E+2	8E-1	3E-10	-	-	-
72	Hafnium-182	D, see ¹⁷⁰ Hf	2E+2	8E-1	3E-10	-	-	-
		W, see ¹⁷⁰ Hf	-	Bone surf (4E+2)	-	2E-12	5E-6	5E-5
		D, see ¹⁷⁰ Hf	2E+4	5E+4	2E-5	6E-8	3E-4	3E-3
72	Hafnium-183 ³	D, see ¹⁷⁰ Hf	2E+4	5E+4	2E-5	6E-8	3E-4	3E-3
		W, see ¹⁷⁰ Hf	-	6E+4	2E-5	8E-8	-	-
		D, see ¹⁷⁰ Hf	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
72	Hafnium-184	D, see ¹⁷⁰ Hf	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		W, see ¹⁷⁰ Hf	-	6E+3	3E-6	9E-9	-	-
		D, see ¹⁷⁰ Hf	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
73	Tantalum-172 ²	W, all compounds except those given for Y	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
73	Tantalum-173	Y, elemental Ta, oxides, hydroxides, halides, carbides, nitrates, and nitrides	-	1E+5	4E-5	1E-7	-	-
		W, see ¹⁷² Ta	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ¹⁷² Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-174 ²	W, see ¹⁷² Ta	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
		Y, see ¹⁷² Ta	-	9E+4	4E-5	1E-7	-	-
		W, see ¹⁷² Ta	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
73	Tantalum-175	W, see ¹⁷² Ta	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
		Y, see ¹⁷² Ta	-	1E+4	6E-6	2E-8	-	-
		W, see ¹⁷² Ta	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
73	Tantalum-177	Y, see ¹⁷² Ta	-	1E+4	5E-6	2E-8	-	-
		W, see ¹⁷² Ta	1E+4	2E+4	8E-6	3E-8	2E-4	2E-3
73	Tantalum-178	Y, see ¹⁷² Ta	-	2E+4	7E-6	2E-8	-	-
		W, see ¹⁷² Ta	2E+4	9E+4	4E-5	1E-7	2E-4	2E-3
73	Tantalum-179	Y, see ¹⁷² Ta	-	7E+4	3E-5	1E-7	-	-
		W, see ¹⁷² Ta	2E+4	5E+3	2E-6	8E-9	3E-4	3E-3
73	Tantalum-180m	Y, see ¹⁷² Ta	-	9E+2	4E-7	1E-9	-	-
		W, see ¹⁷² Ta	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
73	Tantalum-180	Y, see ¹⁷² Ta	-	6E+4	2E-5	8E-8	-	-
		W, see ¹⁷² Ta	1E+3	4E+2	2E-7	6E-10	2E-5	2E-4
73	Tantalum-182m ²	Y, see ¹⁷² Ta	-	2E+1	1E-8	3E-11	-	-
		W, see ¹⁷² Ta	2E+5	5E+5	2E-4	8E-7	-	-
73	Tantalum-182	St wall (2E+5)	-	-	-	-	3E-3	3E-2
		Y, see ¹⁷² Ta	-	4E+5	2E-4	6E-7	-	-
		W, see ¹⁷² Ta	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		Y, see ¹⁷² Ta	-	1E+2	6E-8	2E-10	-	-
73	Tantalum-183	W, see ¹⁷² Ta	9E+2	1E+3	5E-7	2E-9	-	-
		LLI wall (1E+3)	-	-	-	-	2E-5	2E-4
73	Tantalum-184	Y, see ¹⁷² Ta	-	1E+3	4E-7	1E-9	-	-
		W, see ¹⁷² Ta	2E+3	5E+3	2E-6	8E-9	3E-5	3E-4
73	Tantalum-185 ²	Y, see ¹⁷² Ta	-	5E+3	2E-6	7E-9	-	-
		W, see ¹⁷² Ta	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
73	Tantalum-186 ²	Y, see ¹⁷² Ta	-	6E+4	3E-5	9E-8	-	-
		W, see ¹⁷² Ta	5E+4	2E+5	1E-4	3E-7	-	-
74	Tungsten-176	St wall (7E+4)	-	-	-	-	1E-3	1E-2
		Y, see ¹⁷² Ta	-	2E+5	9E-5	3E-7	-	-
74	Tungsten-177	D, all compounds	1E+4	5E+4	2E-5	7E-8	1E-4	1E-3
74	Tungsten-178	D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3
74	Tungsten-179 ²	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	7E+3	3E-6	9E-9	-	-
74	Tungsten-187	LLI wall (3E+3)	-	-	-	-	4E-5	4E-4
		D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4
74	Tungsten-188	D, all compounds	4E+2	1E+3	5E-7	2E-9	-	-
		LLI wall (5E+2)	-	-	-	-	7E-6	7E-5
75	Rhenium-177 ²	D, all compounds except those given for W	9E+4	3E+5	1E-4	4E-7	-	-
		St wall (1E+5)	-	-	-	-	2E-3	2E-2
75	Rhenium-178 ²	W, oxides, hydroxides, and nitrates	-	4E+5	1E-4	5E-7	-	-
		D, see ¹⁷⁷ Re	7E+4	3E+5	1E-4	4E-7	-	-
75	Rhenium-181	St wall (1E+5)	-	-	-	-	1E-3	1E-2
		W, see ¹⁷⁷ Re	-	3E+5	1E-4	4E-7	-	-
75	Rhenium-182	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	D, see ¹⁷⁷ Re	7E+3	1E+4	5E-6	2E-8	9E-5	9E-4

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
	(12.7 h)	W, see ¹⁷⁷ Re	-	2E+4	6E-6	2E-8	-	-
75	Rhenium-182	D, see ¹⁷⁷ Re	1E+3	2E+3	1E-6	3E-9	2E-5	2E-4
	(64.0 h)	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	2E+3	7E-7	-	-	-
		St wall (2E+3)	-	St wall (2E+3)	-	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	4E-4	-	8E-3	8E-2
		St wall (9E+5)	-	St wall (9E+5)	-	1E-6	-	-
		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	-	-
76	Osmium-185	D, see ¹⁸⁰ Os	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ¹⁸⁰ Os	-	8E+2	3E-7	1E-9	-	-
		Y, see ¹⁸⁰ Os	-	8E+2	3E-7	1E-9	-	-
76	Osmium-189m	D, see ¹⁸⁰ Os	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
		W, see ¹⁸⁰ Os	-	2E+5	9E-5	3E-7	-	-
		Y, see ¹⁸⁰ Os	-	2E+5	7E-5	2E-7	-	-
76	Osmium-191m	D, see ¹⁸⁰ Os	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ¹⁸⁰ Os	-	2E+4	8E-6	3E-8	-	-
		Y, see ¹⁸⁰ Os	-	2E+4	7E-6	2E-8	-	-
76	Osmium-191	D, see ¹⁸⁰ Os	2E+3	2E+3	9E-7	3E-9	-	-
		LLI wall (3E+3)	-	-	-	-	3E-5	3E-4
		W, see ¹⁸⁰ Os	-	2E+3	7E-7	2E-9	-	-
		Y, see ¹⁸⁰ Os	-	1E+3	6E-7	2E-9	-	-
76	Osmium-193	D, see ¹⁸⁰ Os	2E+3	5E+3	2E-6	6E-9	-	-
		LLI wall (2E+3)	-	-	-	-	2E-5	2E-4
		W, see ¹⁸⁰ Os	-	3E+3	1E-6	4E-9	-	-
		Y, see ¹⁸⁰ Os	-	3E+3	1E-6	4E-9	-	-
76	Osmium-194	D, see ¹⁸⁰ Os	4E+2	4E+1	2E-8	6E-11	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		W, see ¹⁸⁰ Os	-	6E+1	2E-8	8E-11	-	-
		Y, see ¹⁸⁰ Os	-	8E+0	3E-9	1E-11	-	-
77	Iridium-182 ²	D, all compounds except those given for W and Y	4E+4	1E+5	6E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
		W, halides, nitrates, and metallic iridium	-	2E+5	6E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-
77	Iridium-184	D, see ¹⁸² Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ¹⁸² Ir	-	3E+4	1E-5	5E-8	-	-
		Y, see ¹⁸² Ir	-	3E+4	1E-5	4E-8	-	-
77	Iridium-185	D, see ¹⁸² Ir	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ¹⁸² Ir	-	1E+4	5E-6	2E-8	-	-
		Y, see ¹⁸² Ir	-	1E+4	4E-6	1E-8	-	-
77	Iridium-186	D, see ¹⁸² Ir	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		W, see ¹⁸² Ir	-	6E+3	3E-6	9E-9	-	-
		Y, see ¹⁸² Ir	-	6E+3	2E-6	8E-9	-	-
77	Iridium-187	D, see ¹⁸² Ir	1E+4	3E+4	1E-5	5E-8	1E-4	1E-3
		W, see ¹⁸² Ir	-	3E+4	1E-5	4E-8	-	-
		Y, see ¹⁸² Ir	-	3E+4	1E-5	4E-8	-	-
77	Iridium-188	D, see ¹⁸² Ir	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
		W, see ¹⁸² Ir	-	4E+3	1E-6	5E-9	-	-
		Y, see ¹⁸² Ir	-	3E+3	1E-6	5E-9	-	-
77	Iridium-189	D, see ¹⁸² Ir	5E+3	5E+3	2E-6	7E-9	-	-
			LLI wall (5E+3)	-	-	-	7E-5	7E-4
		W, see ¹⁸² Ir	-	4E+3	2E-6	5E-9	-	-
		Y, see ¹⁸² Ir	-	4E+3	1E-6	5E-9	-	-
77	Iridium-190m ²	D, see ¹⁸² Ir	2E+5	2E+5	8E-5	3E-7	2E-3	2E-2
		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

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
		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	6E+3	3E-6	8E-9	-	-
			LLI wall (3E+4)	-	-	-	4E-5	4E-4
78	Platinum-193	D, all compounds	4E+4	2E+4	1E-5	3E-8	-	-
			LLI wall (5E+4)	-	-	-	6E-4	6E-3
78	Platinum-195m	D, all compounds	2E+3	4E+3	2E-6	6E-9	-	-
			LLI wall (2E+3)	-	-	-	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 ¹⁹³ Au	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		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	-	-
79	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

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
		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 ^{193m} Hg	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{193m} 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 ^{193m} Hg	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
		W, see ^{193m} 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 ^{193m} Hg	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
		W, see ^{193m} 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 ^{193m} Hg	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{193m} 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 ^{193m} Hg	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4
		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

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
82	Lead-198	D, all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
82	Lead-199 ²	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
82	Lead-200	D, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
82	Lead-201	D, all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3
82	Lead-202m	D, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
82	Lead-202	D, all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5
82	Lead-203	D, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
82	Lead-205	D, all compounds	4E+3	1E+3	6E-7	2E-9	5E-5	5E-4
82	Lead-209	D, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
82	Lead-210	D, all compounds	6E-1	2E-1	1E-10	-	-	-
			Bone surf (1E+0)	Bone surf (4E-1)	-	6E-13	1E-8	1E-7
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	3E+1	1E-8	5E-11	-	-
			Bone surf (1E+2)	-	-	-	2E-6	2E-5
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	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
		W, all other compounds	-	1E+5	4E-5	1E-7	-	-
83	Bismuth-201 ²	D, see ²⁰⁰ Bi	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ²⁰⁰ Bi	-	4E+4	2E-5	5E-8	-	-
83	Bismuth-202 ²	D, see ²⁰⁰ Bi	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ²⁰⁰ Bi	-	8E+4	3E-5	1E-7	-	-
83	Bismuth-203	D, see ²⁰⁰ Bi	2E+3	7E+3	3E-6	9E-9	3E-5	3E-4
		W, see ²⁰⁰ Bi	-	6E+3	3E-6	9E-9	-	-
83	Bismuth-205	D, see ²⁰⁰ Bi	1E+3	3E+3	1E-6	3E-9	2E-5	2E-4
		W, see ²⁰⁰ Bi	-	1E+3	5E-7	2E-9	-	-
83	Bismuth-206	D, see ²⁰⁰ Bi	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ²⁰⁰ Bi	-	9E+2	4E-7	1E-9	-	-
83	Bismuth-207	D, see ²⁰⁰ Bi	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ²⁰⁰ Bi	-	4E+2	1E-7	5E-10	-	-
83	Bismuth-210m	D, see ²⁰⁰ Bi	4E+1	5E+0	2E-9	-	-	-
			Kidneys (6E+1)	Kidneys (6E+0)	-	9E-12	8E-7	8E-6
		W, see ²⁰⁰ Bi	-	7E-1	3E-10	9E-13	-	-
83	Bismuth-210	D, see ²⁰⁰ Bi	8E+2	2E+2	1E-7	-	1E-5	1E-4
			-	Kidneys (4E+2)	-	5E-10	-	-
		W, see ²⁰⁰ Bi	-	3E+1	1E-8	4E-11	-	-
83	Bismuth-212 ²	D, see ²⁰⁰ Bi	5E+3	2E+2	1E-7	3E-10	7E-5	7E-4
		W, see ²⁰⁰ Bi	-	3E+2	1E-7	4E-10	-	-
83	Bismuth-213 ²	D, see ²⁰⁰ Bi	7E+3	3E+2	1E-7	4E-10	1E-4	1E-3
		W, see ²⁰⁰ Bi	-	4E+2	1E-7	5E-10	-	-
83	Bismuth-214 ²	D, see ²⁰⁰ Bi	2E+4	8E+2	3E-7	1E-9	-	-
			St wall (2E+4)	-	-	-	3E-4	3E-3
		W, see ²⁰⁰ Bi	-	9E-2	4E-7	1E-9	-	-
84	Polonium-203 ²	D, all compounds except those given for W	3E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, oxides, hydroxides, and nitrates	-	9E+4	4E-5	1E-7	-	-
84	Polonium-205 ²	D, see ²⁰³ Po	2E+4	4E+4	2E-5	5E-8	3E-4	3E-3
		W, see ²⁰³ Po	-	7E+4	3E-5	1E-7	-	-
84	Polonium-207	D, see ²⁰³ Po	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
84	Polonium-210	W, see ²⁰³ Po	-	3E+4	1E-5	4E-8	-	-
		D, see ²⁰³ Po	3E+0	6E-1	3E-10	9E-13	4E-8	4E-7
85	Astatine-207 ²	W, see ²⁰³ Po	-	6E-1	3E-10	9E-13	-	-
		D, halides	6E+3	3E+3	1E-6	4E-9	8E-5	8E-4
85	Astatine-211	W	-	2E+3	9E-7	3E-9	-	-
		D, halides	1E+2	8E+1	3E-8	1E-10	2E-6	2E-5
86	Radon-220	W	-	5E+1	2E-8	8E-11	-	-
		With daughters removed	-	2E+4	7E-6	2E-8	-	-
86	Radon-222	With daughters present	-	2E+1	9E-9	3E-11	-	-
				(or 12 working level months)		(or 1.0 working level)		
86	Radon-222	With daughters removed	-	1E+4	4E-6	1E-8	-	-
		With daughters present	-	1E+2	3E-8	1E-10	-	-
				(or 4 working level months)		(or 0.33 working level)		
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	7E-1	3E-10	9E-13	-	-
			Bone surf (9E+0)	-	-	-	1E-7	1E-6
88	Radium-224	W, all compounds	8E+0	2E+0	7E-10	2E-12	-	-
			Bone surf (2E+1)	-	-	-	2E-7	2E-6
88	Radium-225	W, all compounds	8E+0	7E-1	3E-10	9E-13	-	-
			Bone surf (2E+1)	-	-	-	2E-7	2E-6
88	Radium-226	W, all compounds	2E+0	6E-1	3E-10	9E-13	-	-
			Bone surf (5E+0)	-	-	-	6E-8	6E-7
88	Radium-227 ²	W, all compounds	2E+4	1E+4	6E-6	-	-	-
			Bone surf (2E+4)	Bone surf (2E+4)	-	3E-8	3E-4	3E-3
88	Radium-228	W, all compounds	2E+0	1E+0	5E-10	2E-12	-	-
			Bone surf (4E+0)	-	-	-	6E-8	6E-7
89	Actinium-224	D, all compounds except those given for W and Y	2E+3	3E+1	1E-8	-	-	-
			LLI wall (2E+3)	Bone surf (4E+1)	-	5E-11	3E-5	3E-4
89	Actinium-225	W, halides and nitrates	-	5E+1	2E-8	7E-11	-	-
		Y, oxides and hydroxides	-	5E+1	2E-8	6E-11	-	-
89	Actinium-226	D, see ²²⁴ Ac	5E+1	3E-1	1E-10	-	-	-
			LLI wall (5E+1)	Bone surf (5E-1)	-	7E-13	7E-7	7E-6
89	Actinium-226	W, see ²²⁴ Ac	-	6E-1	3E-10	9E-13	-	-
		Y, see ²²⁴ Ac	-	6E-1	3E-10	9E-13	-	-
89	Actinium-227	D, see ²²⁴ Ac	1E+2	3E+0	1E-9	-	-	-
			LLI wall (1E+2)	Bone surf (4E+0)	-	5E-12	2E-6	2E-5
89	Actinium-227	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	-	-	

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
89	Actinium-228	W, see ²²⁴ Ac	Bone surf (4E-1)	Bone surf (8E-4)	-	1E-15	5E-9	5E-8
			-	2E-3	7E-13	-	-	-
		Y, see ²²⁴ Ac	-	Bone surf (3E-3)	-	4E-15	-	-
			D, see ²²⁴ Ac	2E+3	4E-3	2E-12	6E-15	-
		W, see ²²⁴ Ac	-	9E+0	4E-9	-	3E-5	3E-4
			-	Bone surf (2E+1)	-	2E-11	-	-
-	4E+1		2E-8	-	-	-		
-	Bone surf (6E+1)		-	8E-11	-	-		
90	Thorium-226 ^a	Y, see ²²⁴ Ac	-	4E+1	2E-8	6E-11	-	-
		W, all compounds except those given for Y	5E+3	2E+2	6E-8	2E-10	-	-
90	Thorium-227	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
90	Thorium-228	Y, see ²²⁶ Th	-	3E-1	1E-10	5E-13	-	-
90	Thorium-229	W, see ²²⁶ Th	6E+0	1E-2	4E-12	-	-	-
			Bone surf (1E+1)	Bone surf (2E-2)	-	3E-14	2E-7	2E-6
		Y, see ²²⁶ Th	-	2E-2	7E-12	2E-14	-	-
		W, see ²²⁶ Th	6E-1	9E-4	4E-13	-	-	-
90	Thorium-230	W, see ²²⁶ Th	Bone surf (1E+0)	Bone surf (2E-3)	-	3E-15	2E-8	2E-7
			-	2E-3	1E-12	-	-	-
		Y, see ²²⁶ Th	-	Bone surf (3E-3)	-	4E-15	-	-
		W, see ²²⁶ Th	4E+0	6E-3	3E-12	-	-	-
90	Thorium-231	Y, see ²²⁶ Th	Bone surf (9E+0)	Bone surf (2E-2)	-	2E-14	1E-7	1E-6
		-	2E-2	6E-12	-	-	-	
90	Thorium-232	W, see ²²⁶ Th	-	Bone surf (2E-2)	-	3E-14	-	-
			4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
90	Thorium-232	W, see ²²⁶ Th	-	6E+3	3E-6	9E-9	-	-
			7E-1	1E-3	5E-13	-	-	-
90	Thorium-234	W, see ²²⁶ Th	Bone surf (2E+0)	Bone surf (3E-3)	-	4E-15	3E-8	3E-7
			-	3E-3	1E-12	-	-	-
		Y, see ²²⁶ Th	-	Bone surf (4E-3)	-	6E-15	-	-
		W, see ²²⁶ Th	3E+2	2E+2	8E-8	3E-10	-	-
91	Protactinium-227 ^b	LLI wall (4E+2)	-	-	-	5E-6	5E-5	
		Y, see ²²⁶ Th	-	2E+2	6E-8	2E-10	-	-
91	Protactinium-228	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	-	-
91	Protactinium-230	W, see ²²⁷ Pa	1E+3	1E+1	5E-9	-	2E-5	2E-4
			-	Bone surf (2E+1)	-	3E-11	-	-
91	Protactinium-230	Y, see ²²⁷ Pa	-	1E+1	5E-9	2E-11	-	-
		W, see ²²⁷ Pa	6E+2	5E+0	2E-9	7E-12	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
91	Protactinium-231	Y, see ²²⁷ Pa	Bone surf (9E+2)	-	-	-	1E-5	1E-4
		W, see ²²⁷ Pa	-	4E+0	1E-9	5E-12	-	-
			2E-1	2E-3	6E-13	-	-	-
91	Protactinium-232	Y, see ²²⁷ Pa	Bone surf (5E-1)	Bone surf (4E-3)	-	6E-15	6E-9	6E-8
			-	4E-3	2E-12	-	-	-
		W, see ²²⁷ Pa	-	Bone surf (6E-3)	-	8E-15	-	-
91	Protactinium-233	Y, see ²²⁷ Pa	1E+3	2E+1	9E-9	-	2E-5	2E-4
			-	Bone surf (6E+1)	-	8E-11	-	-
		W, see ²²⁷ Pa	-	6E+1	2E-8	-	-	-
91	Protactinium-234	Y, see ²²⁷ Pa	-	Bone surf (7E+1)	-	1E-10	-	-
		W, see ²²⁷ Pa	1E+3	7E+2	3E-7	1E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
92	Uranium-230	Y, see ²²⁷ Pa	-	6E+2	2E-7	8E-10	-	-
		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-231	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	-	-
92	Uranium-232	Y, UO ₂ , U ₃ O ₈	-	3E-1	1E-10	4E-13	-	-
		D, see ²³⁰ U	5E+3	8E+3	3E-6	1E-8	-	-
			LLI wall (4E+3)	-	-	-	6E-5	6E-4
92	Uranium-233	W, see ²³⁰ U	-	6E+3	2E-6	8E-9	-	-
		Y, see ²³⁰ U	-	5E+3	2E-6	6E-9	-	-
		D, see ²³⁰ U	2E+0	2E-1	9E-11	-	-	-
92	Uranium-234 ³	W, see ²³⁰ U	Bone surf (4E+0)	Bone surf (4E-1)	-	6E-13	6E-8	6E-7
		Y, see ²³⁰ U	-	4E-1	2E-10	5E-13	-	-
		D, see ²³⁰ U	-	8E-3	3E-12	1E-14	-	-
92	Uranium-235 ³	W, see ²³⁰ U	1E+1	1E+0	5E-10	-	-	-
		Y, see ²³⁰ U	Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		D, see ²³⁰ U	-	7E-1	3E-10	1E-12	-	-
92	Uranium-236	W, see ²³⁰ U	-	4E-2	2E-11	5E-14	-	-
		Y, see ²³⁰ U	-	4E-2	2E-11	5E-14	-	-
		D, see ²³⁰ U	1E+1	1E+0	5E-10	-	-	-
92	Uranium-235 ³	W, see ²³⁰ U	Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		Y, see ²³⁰ U	-	8E-1	3E-10	1E-12	-	-
		D, see ²³⁰ U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-236	W, see ²³⁰ U	1E+1	1E+0	5E-10	-	-	-
		Y, see ²³⁰ U	Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		D, see ²³⁰ U	-	8E-1	3E-10	1E-12	-	-
92	Uranium-236	W, see ²³⁰ U	-	4E-2	2E-11	6E-14	-	-
		Y, see ²³⁰ U	-	4E-2	2E-11	6E-14	-	-
		D, see ²³⁰ U	1E+1	1E+0	5E-10	-	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
92	Uranium-237	D, see ²³⁰ U	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		W, see ²³⁰ U	-	2E+3	7E-7	2E-9	-	-
92	Uranium-238 ³	Y, see ²³⁰ U	-	2E+3	6E-7	2E-9	-	-
		D, see ²³⁰ U	1E+1	1E+0	6E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
92	Uranium-238 ³	W, see ²³⁰ U	-	8E-1	3E-10	1E-12	-	-
		Y, see ²³⁰ U	-	4E-2	2E-11	6E-14	-	-
		D, see ²³⁰ U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
92	Uranium-239 ³	W, see ²³⁰ U	-	2E+5	7E-5	2E-7	-	-
		Y, see ²³⁰ U	-	2E+5	6E-5	2E-7	-	-
		D, see ²³⁰ U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
92	Uranium-240	W, see ²³⁰ U	-	3E+3	1E-6	4E-9	-	-
		Y, see ²³⁰ U	-	2E+3	1E-6	3E-9	-	-
		D, see ²³⁰ U	1E+1	1E+0	5E-10	-	-	-
92	Uranium-natural ³		Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ²³⁰ U	-	8E-1	3E-10	9E-13	-	-
		Y, see ²³⁰ U	-	5E-2	2E-11	9E-14	-	-
93	Neptunium-232 ²	W, all compounds	1E+5	2E+3	7E-7	-	2E-3	2E-2
			-	Bone surf (5E+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	8E+2	3E-7	-	-	-
93	Neptunium-236 (1.15E+5 y)		LLI wall (2E+4)	Bone surf (1E+3)	-	2E-9	3E-4	3E-3
		W, all compounds	3E+0	2E-2	9E-12	-	-	-
93	Neptunium-236 (22.5 h)		Bone surf (6E+0)	Bone surf (5E-2)	-	8E-14	9E-8	9E-7
		W, all compounds	3E+3	3E+1	1E-8	-	-	-
93	Neptunium-237		Bone surf (4E+3)	Bone surf (7E+1)	-	1E-10	5E-5	5E-4
		W, all compounds	5E-1	4E-3	2E-12	-	-	-
93	Neptunium-238		Bone surf (1E+0)	Bone surf (1E-2)	-	1E-14	2E-8	2E-7
		W, all compounds	1E+3	6E+1	3E-8	-	2E-5	2E-4
93	Neptunium-239		-	Bone surf (2E+2)	-	2E-10	-	-
		W, all compounds	2E+3	2E+3	9E-7	3E-9	-	-
93	Neptunium-240 ²	W, all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
94	Plutonium-234	W, all compounds except PuO ₂	8E+3	2E+2	9E-8	3E-10	1E-4	1E-3
		Y, PuO ₂	-	2E+2	8E-8	3E-10	-	-
94	Plutonium-235 ²	W, see ²³⁴ Pu	9E+5	3E+6	1E-3	4E-6	1E-2	1E-1
		Y, see ²³⁴ Pu	-	3E+6	1E-3	3E-6	-	-
94	Plutonium-236	W, see ²³⁴ Pu	2E+0	2E-2	8E-12	-	-	-
			Bone surf (4E+0)	Bone surf (4E-2)	-	5E-14	6E-8	6E-7
94	Plutonium-237	Y, see ²³⁴ Pu	-	4E-2	2E-11	6E-14	-	-
		W, see ²³⁴ Pu	1E+4	3E+3	1E-6	5E-9	2E-4	2E-3

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
94	Plutonium-238	Y, see ²³⁸ Pu	-	3E+3	1E-6	4E-9	-	-
		W, see ²³⁸ Pu	9E-1	7E-3	3E-12	-	-	-
94	Plutonium-239	Bone surf (2E+0)	-	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ²³⁹ Pu	-	2E-2	8E-12	2E-14	-	-
		W, see ²³⁹ Pu	8E-1	6E-3	3E-12	-	-	-
94	Plutonium-240	Bone surf (1E+0)	-	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ²⁴⁰ Pu	-	2E-2	7E-12	-	-	-
		W, see ²⁴⁰ Pu	8E-1	6E-3	3E-12	-	-	-
		Bone surf (1E+0)	-	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
94	Plutonium-241	Y, see ²⁴¹ Pu	-	2E-2	7E-12	-	-	-
		W, see ²⁴¹ Pu	4E+1	3E-1	1E-10	-	-	-
		Bone surf (7E+1)	-	Bone surf (6E-1)	-	8E-13	1E-6	1E-5
94	Plutonium-242	Y, see ²⁴² Pu	-	8E-1	3E-10	-	-	-
		W, see ²⁴² Pu	8E-1	7E-3	3E-12	-	-	-
		Bone surf (1E+0)	-	Bone surf (1E-2)	-	1E-12	-	-
		Y, see ²⁴² Pu	-	2E-2	7E-12	-	-	-
94	Plutonium-243	W, see ²⁴³ Pu	2E+4	4E+4	2E-5	5E-8	2E-4	2E-3
		Y, see ²⁴³ Pu	-	4E+4	2E-5	5E-8	-	-
94	Plutonium-244	W, see ²⁴⁴ Pu	8E-1	7E-3	3E-12	-	-	-
		Bone surf (2E+0)	-	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ²⁴⁴ Pu	-	2E-2	7E-12	-	-	-
94	Plutonium-245	W, see ²⁴⁵ Pu	-	Bone surf (2E-2)	-	2E-14	-	-
		Y, see ²⁴⁵ Pu	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
94	Plutonium-246	Y, see ²⁴⁶ Pu	-	4E+3	2E-6	6E-9	-	-
		W, see ²⁴⁶ Pu	4E+2	3E+2	1E-7	4E-10	-	-
95	Americium-237 ²	LLI wall (4E+2)	-	-	-	-	6E-6	6E-5
		Y, see ²³⁷ Pu	-	3E+2	1E-7	4E-10	-	-
95	Americium-238 ²	W, all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2
95	Americium-239	W, all compounds	4E+4	3E+3	1E-6	-	5E-4	5E-3
		Bone surf (6E+3)	-	Bone surf (1E+3)	-	9E-9	-	-
95	Americium-240	W, all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
95	Americium-241	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
95	Americium-242m	W, all compounds	8E-1	6E-3	3E-12	-	-	-
		Bone surf (1E+0)	-	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242	W, all compounds	8E-1	6E-3	3E-12	-	-	-
		Bone surf (1E+0)	-	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242	W, all compounds	4E+3	8E+1	4E-8	-	5E-5	5E-4

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
95	Americium-243	W, all compounds	-	Bone surf (9E+1)	-	1E-10	-	-
			8E-1	6E-3	3E-12	-	-	-
95	Americium-244m ²	W, all compounds	Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
			6E+4	4E+3	2E-6	-	-	-
95	Americium-244	W, all compounds	St wall (8E+4)	Bone surf (7E+3)	-	1E-8	1E-3	1E-2
			3E+3	2E+2	8E-8	-	4E-5	4E-4
95	Americium-245	W, all compounds	-	Bone surf (3E+2)	-	4E-10	-	-
			3E+4	8E+4	3E-5	1E-7	4E-4	4E-3
95	Americium-246m ²	W, all compounds	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (6E+4)	-	-	-	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	6E-1	2E-10	-	-	-
			Bone surf (8E+1)	Bone surf (6E-1)	-	9E-13	1E-6	1E-5
96	Curium-241	W, all compounds	1E+3	3E+1	1E-8	-	2E-5	2E-4
			-	Bone surf (4E+1)	-	5E-11	-	-
96	Curium-242	W, all compounds	3E+1	3E-1	1E-10	-	-	-
			Bone surf (5E+1)	Bone surf (3E-1)	-	4E-13	7E-7	7E-6
96	Curium-243	W, all compounds	1E+0	9E-3	4E-12	-	-	-
			Bone surf (2E+0)	Bone surf (2E-2)	-	2E-14	3E-8	3E-7
96	Curium-244	W, all compounds	1E+0	1E-2	5E-12	-	-	-
			Bone surf (3E+0)	Bone surf (2E-2)	-	3E-14	3E-8	3E-7
96	Curium-245	W, all compounds	7E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-246	W, all compounds	7E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-247	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-248	W, all compounds	2E-1	2E-3	7E-13	-	-	-
			Bone surf (4E-1)	Bone surf (3E-3)	-	4E-15	5E-9	5E-8
96	Curium-249 ²	W, all compounds	5E+4	2E+4	7E-6	-	7E-4	7E-3
			-	Bone surf (3E+4)	-	4E-8	-	-
96	Curium-250	W, all compounds	4E-2	3E-4	1E-13	-	-	-
			Bone surf (6E-2)	Bone surf (5E-4)	-	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	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
97	Berkelium-249	W, all compounds	2E+2	2E+0	7E-10	-	-	-
			Bone surf (5E+2)	Bone surf (4E+0)	-	5E-12	6E-6	6E-5

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
97	Berkelium-250	W, all compounds	9E+3	3E+2	1E-7	-	1E-4	1E-3
			-	Bone surf (7E+2)	-	1E-9	-	-
98	Californium-244 ²	W, all compounds except those given for Y	3E+4	6E+2	2E-7	8E-10	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		Y, oxides and hydroxides	-	6E+2	2E-7	8E-10	-	-
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	6E-2	3E-11	-	-	-
			Bone surf (2E+1)	Bone surf (1E-1)	-	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	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
		Y, see ²⁴⁴ Cf	-	1E-2	4E-12	-	-	-
			-	Bone surf (1E-2)	-	2E-14	-	-
98	Californium-250	W, see ²⁴⁴ Cf	1E+0	9E-3	4E-12	-	-	-
			Bone surf (2E+0)	Bone surf (2E-2)	-	3E-14	3E-8	3E-7
		Y, see ²⁴⁴ Cf	-	3E-2	1E-11	4E-14	-	-
98	Californium-251	W, see ²⁴⁴ Cf	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
		Y, see ²⁴⁴ Cf	-	1E-2	4E-12	-	-	-
			-	Bone surf (1E-2)	-	2E-14	-	-
98	Californium-252	W, see ²⁴⁴ Cf	2E+0	2E-2	8E-12	-	-	-
			Bone surf (5E+0)	Bone surf (4E-2)	-	5E-14	7E-8	7E-7
		Y, see ²⁴⁴ Cf	-	3E-2	1E-11	5E-14	-	-
98	Californium-253	W, see ²⁴⁴ Cf	2E+2	2E+0	8E-10	3E-12	-	-
			Bone surf (4E+2)	-	-	-	5E-6	5E-5
		Y, see ²⁴⁴ Cf	-	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	2E-7	-	6E-4	6E-3
			-	Bone surf (1E+3)	-	2E-9	-	-
99	Einsteinium-251	W, all compounds	7E+3	9E+2	4E-7	-	1E-4	1E-3
			-	Bone surf (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	1E+1	4E-9	1E-11	-	-
			LLI wall (3E+2)	-	-	-	4E-6	4E-5
99	Einsteinium-254	W, all compounds	8E+0	7E-2	3E-11	-	-	-
			Bone surf (2E+1)	Bone surf (1E-1)	-	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

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentration		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration μCi/ml
			Oral Ingestion ALI μCi	Inhalation		Air μCi/ml	Water μCi/ml	
				ALI μCi	DAC μCi/ml			
100	Fermium-257	W, all compounds	2E+1	2E-1	7E-11	-	-	-
			Bone surf (4E+1)	Bone surf (2E-1)	-	3E-13	5E-7	5E-6
101	Mendelevium-257	W, all compounds	7E+3	8E+1	4E-8	-	1E-4	1E-3
			-	Bone surf (9E+1)	-	1E-10	-	-
101	Mendelevium-258	W, all compounds	3E+1	2E-1	1E-10	-	-	-
			Bone surf (5E+1)	Bone surf (3E-1)	-	5E-13	6E-7	6E-6
-	Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours	Submersion ¹	-	2E+2	1E-7	1E-9	-	-
-	Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours	...	-	2E-1	1E-10	1E-12	1E-8	1E-7
-	Any single radionuclide not listed above that decays by alpha emission or spontaneous fission, or any mixture for which either the identity or the concentration of any radionuclide in the mixture is not known	...	-	4E-4	2E-13	1E-15	2E-9	2E-8

FOOTNOTES:

¹"Submersion" means that values given are for submersion in a hemispherical semi-infinite cloud of airborne material.

²These radionuclides have radiological half-lives of less than 2 hours. The total effective dose equivalent received during operations with these radionuclides might include a significant contribution from external exposure. The DAC values for all radionuclides, other than those designated Class "Submersion," are based upon the committed effective dose equivalent due to the intake of the radionuclide into the body and do NOT include potentially significant contributions to dose equivalent from external exposures. The licensee may substitute 1E-7 μCi/ml for the listed DAC to account for the submersion dose prospectively, but should use individual monitoring devices or other radiation measuring instruments that measure external exposure to demonstrate compliance with the limits. (See WAC 246-221-015(5).)

³For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor (see WAC 246-221-010(5)). If the percent by weight (enrichment) of U-235 is not greater than 5, the concentration value for a 40-hour workweek is 0.2 milligrams uranium per cubic meter of air average. For any enrichment, the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed 8E-3 (SA) μCi-hr/ml, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is 6.77E-7 curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, shall be:

SA = 3.6E-7 curies/gram U, U-depleted

SA = [0.4 + 0.38 (enrichment) + 0.0034 (enrichment)²] E-6, enrichment ≥ 0.72 where enrichment is the percentage by weight of U-235, expressed as percent.

NOTE:

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

2. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in this appendix are not present in the mixture, the inhalation ALI, DAC, and effluent and sewage concentrations for the mixture are the lowest values specified in this appendix for any radionuclide that is not known to be absent from the mixture; or

If it is known that Ac-227-D and Cm-250-W are not present

- 7E-4 3E-13 - - -

If, in addition, it is known that Ac-227-W,Y, Th-229-W,Y, Th-230-W, Th-232-W,Y, Pa-231-W,Y, Np-237-W, Pu-239-W, Pu-240-W, Pu-242-W, Am-241-W, Am-242m-W, Am-243-W, Cm-245-W, Cm-246-W, Cm-247-W, Cm-248-W, Bk-247-W, Cf-249-W, and Cf-251-W are not present

- 7E-3 3E-12 - - -

If, in addition, it is known that Sm-146-W, Sm-147-W, Gd-148-D,W, Gd-152-D,W, Th-228-W,Y, Th-230-Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, Np-236-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-Y, Pu-240-Y, Pu-242-Y, Pu-244-W,Y, Cm-243-W, Cm-244-W, Cf-248-W, Cf-249-Y, Cf-250-W,Y, Cf-251-Y, Cf-252-W,Y, and Cf-254-W,Y are not present

- 7E-2 3E-11 - - -

If, in addition, it is known that Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-Y, Es-254-W, Fm-257-W, and Md-258-W are not present

- 7E-1 3E-10 - - -

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, Cm-243-W, Cm-244-W, Cm-245-W, Cm-246-W, Cm-247-W, Bk-247-W, Cf-249-W,Y, Cf-250-W,Y, Cf-251-W,Y, Cf-252-W,Y, and Cf-254-W,Y are not present

- - - 1E-13 - -

If, in addition, it is known that Sm-147-W, Gd-152-W, Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, U-Nat-W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-W,Y, Es-254-W, Fm-257-W, and Md-258-W are not present

- - - - 1E-12 -

If, in addition, it is known that Fe-60, Sr-90, Cd-113m, Cd-113, In-115, I-129, Cs-134, Sm-145, Sm-147, Gd-148, Gd-152, Hg-194 (organic), Bi-210m, Ra-223, Ra-224, Ra-225, Ac-225, Th-228, Th-230, U-233, U-234, U-235, U-236, U-238, U-Nat, Cm-242, Cf-248, Es-254, Fm-257, and Md-258 are not present

- - - - 1E-6 1E-5

3. If a mixture of radionuclides consists of uranium and its daughters in 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 this section 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:

$$\frac{C_A}{DAC_A} + \frac{C_B}{DAC_B} + \frac{C_C}{DAC_C} \leq 1$$

[Statutory Authority: RCW 70.98.050. WSR 11-03-068, § 246-221-290, filed 1/18/11, effective 2/18/11. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 09-06-003, § 246-221-290, filed 2/18/09, effective 3/21/09. Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-290, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 43.70 040. WSR 91-02-049 (Order 121), recodified as § 246-221-290, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-220, filed 12/8/80; Order 1095, §

402-24-220, filed 2/6/76; Order 1, § 402-24-220, filed 1/8/69; Rules (part), filed 10/26/66.]

Reviser's note: The brackets and enclosed material in the text of the above section occurred in the copy filed by the agency.

WAC 246-221-300 Appendix B—Minimum quantities of radioactive material requiring labeling.

Minimum Quantities¹ of Radioactive Material Requiring Labeling

Radionuclide	Quantity*(μ Ci)
Actinium-224	1
Actinium-225	0.01
Actinium-226	0.1
Actinium-227	0.001
Actinium-228	1
Aluminum-26	10
Americium-237	1,000
Americium-238	100
Americium-239	1,000
Americium-240	100
Americium-241	0.001
Americium-242	10
Americium-242m	0.001
Americium-243	0.001
Americium-244	10
Americium-244m	100
Americium-245	1,000
Americium-246	1,000
Americium-246m	1,000
Antimony-115	1,000
Antimony-116	1,000
Antimony-116m	1,000
Antimony-117	1,000
Antimony-118m	1,000
Antimony-119	1,000
Antimony-120 (16min)	1,000
Antimony-120 (5.76d)	100
Antimony-122	100
Antimony-124	10
Antimony-124m	1,000
Antimony-125	100

Radionuclide	Quantity*(μ Ci)
Antimony-126	100
Antimony-126m	1,000
Antimony-127	100
Antimony-128 (9.01h)	100
Antimony-128 (10.4min)	1,000
Antimony-129	100
Antimony-130	1,000
Antimony-131	1,000
Argon-39	1,000
Argon-41	1,000
Arsenic-69	1,000
Arsenic-70	1,000
Arsenic-71	100
Arsenic-72	100
Arsenic-73	100
Arsenic-74	100
Arsenic-76	100
Arsenic-77	100
Arsenic-78	1,000
Astatine-207	100
Astatine-211	10
Barium-126	1,000
Barium-128	100
Barium-131	100
Barium-131m	1,000
Barium-133	100
Barium-133m	100
Barium-135m	100
Barium-139	1,000
Barium-140	100
Barium-141	1,000
Barium-142	1,000
Berkelium-245	100
Berkelium-246	100
Berkelium-247	0.001
Berkelium-249	0.1
Berkelium-250	10
Beryllium-7	1,000
Beryllium-10	1
Bismuth-200	1,000
Bismuth-201	1,000
Bismuth-202	1,000
Bismuth-203	100
Bismuth-205	100
Bismuth-206	100
Bismuth-207	10
Bismuth-210	1
Bismuth-210m	0.1
Bismuth-212	10

Radionuclide	Quantity*(μ Ci)
Bismuth-213	10
Bismuth-214	100
Bromine-74	1,000
Bromine-74m	1,000
Bromine-75	1,000
Bromine-76	100
Bromine-77	1,000
Bromine-80	1,000
Bromine-80m	1,000
Bromine-82	100
Bromine-83	1,000
Bromine-84	1,000
Cadmium-104	1,000
Cadmium-107	1,000
Cadmium-109	1
Cadmium-113	100
Cadmium-113m	0.1
Cadmium-115	100
Cadmium-115m	10
Cadmium-117	1,000
Cadmium-117m	1,000
Calcium-41	100
Calcium-45	100
Calcium-47	100
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
Carbon-11	1,000
Carbon-14	1,000
Cerium-134	100
Cerium-135	100
Cerium-137	1,000
Cerium-137m	100
Cerium-139	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Cesium-125	1,000
Cesium-127	1,000
Cesium-129	1,000
Cesium-130	1,000
Cesium-131	1,000
Cesium-132	100

Radionuclide	Quantity*(μ Ci)
Cesium-134	10
Cesium-134m	1,000
Cesium-135	100
Cesium-135m	1,000
Cesium-136	10
Cesium-137	10
Cesium-138	1,000
Chlorine-36	10
Chlorine-38	1,000
Chlorine-39	1,000
Chromium-48	1,000
Chromium-49	1,000
Chromium-51	1,000
Cobalt-55	100
Cobalt-56	10
Cobalt-57	100
Cobalt-58	100
Cobalt-58m	1,000
Cobalt-60	1
Cobalt-60m	1,000
Cobalt-61	1,000
Cobalt-62m	1,000
Copper-60	1,000
Copper-61	1,000
Copper-64	1,000
Copper-67	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
Dysprosium-155	1,000
Dysprosium-157	1,000
Dysprosium-159	100
Dysprosium-165	1,000
Dysprosium-166	100
Einsteinium-250	100
Einsteinium-251	100
Einsteinium-253	0.1
Einsteinium-254	0.01
Einsteinium-254m	1
Erbium-161	1,000
Erbium-165	1,000

Radionuclide	Quantity*(μ Ci)
Erbium-169	100
Erbium-171	100
Erbium-172	100
Europium-145	100
Europium-146	100
Europium-147	100
Europium-148	10
Europium-149	100
Europium-150 (12.62h)	100
Europium-150 (34.2y)	1
Europium-152	1
Europium-152m	100
Europium-154	1
Europium-155	10
Europium-156	100
Europium-157	100
Europium-158	1,000
Fermium-252	1
Fermium-253	1
Fermium-254	10
Fermium-255	1
Fermium-257	0.01
Fluorine-18	1,000
Francium-222	100
Francium-223	100
Gadolinium-145	1,000
Gadolinium-146	10
Gadolinium-147	100
Gadolinium-148	0.001
Gadolinium-149	100
Gadolinium-151	10
Gadolinium-152	100
Gadolinium-153	10
Gadolinium-159	100
Gallium-65	1,000
Gallium-66	100
Gallium-67	1,000
Gallium-68	1,000
Gallium-70	1,000
Gallium-72	100
Gallium-73	1,000
Germanium-66	1,000
Germanium-67	1,000
Germanium-68	10
Germanium-69	1,000
Germanium-71	1,000
Germanium-75	1,000
Germanium-77	1,000
Germanium-78	1,000

Radionuclide	Quantity*(μ Ci)
Gold-193	1,000
Gold-194	100
Gold-195	10
Gold-198	100
Gold-198m	100
Gold-199	100
Gold-200	1,000
Gold-200m	100
Gold-201	1,000
Hafnium-170	100
Hafnium-172	1
Hafnium-173	1,000
Hafnium-175	100
Hafnium-177m	1,000
Hafnium-178m	0.1
Hafnium-179m	10
Hafnium-180m	1,000
Hafnium-181	10
Hafnium-182	0.1
Hafnium-182m	1,000
Hafnium-183	1,000
Hafnium-184	100
Holmium-155	1,000
Holmium-157	1,000
Holmium-159	1,000
Holmium-161	1,000
Holmium-162	1,000
Holmium-162m	1,000
Holmium-164	1,000
Holmium-164m	1,000
Holmium-166	100
Holmium-166m	1
Holmium-167	1,000
Hydrogen-3	1,000
Indium-109	1,000
Indium-110 (4.9h)	1,000
Indium-110m (69.1min)	1,000
Indium-111	100
Indium-112	1,000
Indium-113m	1,000
Indium-114m	10
Indium-115	100
Indium-115m	1,000
Indium-116m	1,000
Indium-117	1,000
Indium-117m	1,000
Indium-119m	1,000
Iodine-120	100
Iodine-120m	1,000

Radionuclide	Quantity*(μ Ci)
Iodine-121	1,000
Iodine-123	100
Iodine-124	10
Iodine-125	1
Iodine-126	1
Iodine-128	1,000
Iodine-129	1
Iodine-130	10
Iodine-131	1
Iodine-132	100
Iodine-132m	100
Iodine-133	10
Iodine-134	1,000
Iodine-135	100
Iridium-182	1,000
Iridium-184	1,000
Iridium-185	1,000
Iridium-186	100
Iridium-187	1,000
Iridium-188	100
Iridium-189	100
Iridium-190	100
Iridium-190m	1,000
Iridium-192 (73.8d)	1
Iridium-192m (1.4min)	10
Iridium-194	100
Iridium-194m	10
Iridium-195	1,000
Iridium-195m	1,000
Iron-52	100
Iron-55	100
Iron-59	10
Iron-60	1
Krypton-74	1,000
Krypton-76	1,000
Krypton-77	1,000
Krypton-79	1,000
Krypton-81	1,000
Krypton-83m	1,000
Krypton-85	1,000
Krypton-85m	1,000
Krypton-87	1,000
Krypton-88	1,000
Lanthanum-131	1,000
Lanthanum-132	100
Lanthanum-135	1,000
Lanthanum-137	10
Lanthanum-138	100
Lanthanum-140	100

Radionuclide	Quantity*(μ Ci)
Lanthanum-141	100
Lanthanum-142	1,000
Lanthanum-143	1,000
Lead-195m	1,000
Lead-198	1,000
Lead-199	1,000
Lead-200	100
Lead-201	1,000
Lead-202	10
Lead-202m	1,000
Lead-203	1,000
Lead-205	100
Lead-209	1,000
Lead-210	0.01
Lead-211	100
Lead-212	1
Lead-214	100
Lutetium-169	100
Lutetium-170	100
Lutetium-171	100
Lutetium-172	100
Lutetium-173	10
Lutetium-174	10
Lutetium-174m	10
Lutetium-176	100
Lutetium-176m	1,000
Lutetium-177	100
Lutetium-177m	10
Lutetium-178	1,000
Lutetium-178m	1,000
Lutetium-179	1,000
Magnesium-28	100
Manganese-51	1,000
Manganese-52	100
Manganese-52m	1,000
Manganese-53	1,000
Manganese-54	100
Manganese-56	1,000
Mendelevium-257	10
Mendelevium-258	0.01
Mercury-193	1,000
Mercury-193m	100
Mercury-194	1
Mercury-195	1,000
Mercury-195m	100
Mercury-197	1,000
Mercury-197m	100
Mercury-199m	1,000
Mercury-203	100

Radionuclide	Quantity*(μ Ci)
Molybdenum-90	100
Molybdenum-93	10
Molybdenum-93m	100
Molybdenum-99	100
Molybdenum-101	1,000
Neodymium-136	1,000
Neodymium-138	100
Neodymium-139	1,000
Neodymium-139m	1,000
Neodymium-141	1,000
Neodymium-147	100
Neodymium-149	1,000
Neodymium-151	1,000
Neptunium-232	100
Neptunium-233	1,000
Neptunium-234	100
Neptunium-235	100
Neptunium-236 (1.15E+5y)	0.001
Neptunium-236 (22.5h)	1
Neptunium-237	0.001
Neptunium-238	10
Neptunium-239	100
Neptunium-240	1,000
Nickel-56	100
Nickel-57	100
Nickel-59	100
Nickel-63	100
Nickel-65	1,000
Nickel-66	10
Niobium-88	1,000
Niobium-89 (122min)	1,000
Niobium-89m (66min)	1,000
Niobium-90	100
Niobium-93m	10
Niobium-94	1
Niobium-95	100
Niobium-95m	100
Niobium-96	100
Niobium-97	1,000
Niobium-98	1,000
Osmium-180	1,000
Osmium-181	1,000
Osmium-182	100
Osmium-185	100
Osmium-189m	1,000
Osmium-191	100
Osmium-191m	1,000
Osmium-193	100
Osmium-194	1

Radionuclide	Quantity*(μ Ci)
Palladium-100	100
Palladium-101	1,000
Palladium-103	100
Palladium-107	10
Palladium-109	100
Phosphorus-32	10
Phosphorus-33	100
Platinum-186	1,000
Platinum-188	100
Platinum-189	1,000
Platinum-191	100
Platinum-193	1,000
Platinum-193m	100
Platinum-195m	100
Platinum-197	100
Platinum-197m	1,000
Platinum-199	1,000
Platinum-200	100
Plutonium-234	10
Plutonium-235	1,000
Plutonium-236	0.001
Plutonium-237	100
Plutonium-238	0.001
Plutonium-239	0.001
Plutonium-240	0.001
Plutonium-241	0.01
Plutonium-242	0.001
Plutonium-243	1,000
Plutonium-244	0.001
Plutonium-245	100
Polonium-203	1,000
Polonium-205	1,000
Polonium-207	1,000
Polonium-210	0.1
Potassium-40	100
Potassium-42	1,000
Potassium-43	1,000
Potassium-44	1,000
Potassium-45	1,000
Praseodymium-136	1,000
Praseodymium-137	1,000
Praseodymium-138m	1,000
Praseodymium-139	1,000
Praseodymium-142	100
Praseodymium-142m	1,000
Praseodymium-143	100
Praseodymium-144	1,000
Praseodymium-145	100
Praseodymium-147	1,000

Radionuclide	Quantity*(μ Ci)
Promethium-141	1,000
Promethium-143	100
Promethium-144	10
Promethium-145	10
Promethium-146	1
Promethium-147	10
Promethium-148	10
Promethium-148m	10
Promethium-149	100
Promethium-150	1,000
Promethium-151	100
Protactinium-227	10
Protactinium-228	1
Protactinium-230	0.1
Protactinium-231	0.001
Protactinium-232	1
Protactinium-233	100
Protactinium-234	100
Radium-223	0.1
Radium-224	0.1
Radium-225	0.1
Radium-226	0.1
Radium-227	1,000
Radium-228	0.1
Radon-220	1
Radon-222	1
Rhenium-177	1,000
Rhenium-178	1,000
Rhenium-181	1,000
Rhenium-182 (64.0h)	100
Rhenium-182 (12.7h)	1,000
Rhenium-184	100
Rhenium-184m	10
Rhenium-186	100
Rhenium-186m	10
Rhenium-187	1,000
Rhenium-188	100
Rhenium-188m	1,000
Rhenium-189	100
Rhodium-99	100
Rhodium-99m	1,000
Rhodium-100	100
Rhodium-101	10
Rhodium-101m	1,000
Rhodium-102	10
Rhodium-102m	10
Rhodium-103m	1,000
Rhodium-105	100
Rhodium-106m	1,000

Radionuclide	Quantity*(μ Ci)
Rhodium-107	1,000
Rubidium-79	1,000
Rubidium-81	1,000
Rubidium-81m	1,000
Rubidium-82m	1,000
Rubidium-83	100
Rubidium-84	100
Rubidium-86	100
Rubidium-87	100
Rubidium-88	1,000
Rubidium-89	1,000
Ruthenium-94	1,000
Ruthenium-97	1,000
Ruthenium-103	100
Ruthenium-105	1,000
Ruthenium-106	1
Samarium-141	1,000
Samarium-141m	1,000
Samarium-142	1,000
Samarium-145	100
Samarium-146	1
Samarium-147	100
Samarium-151	10
Samarium-153	100
Samarium-155	1,000
Samarium-156	1,000
Scandium-43	1,000
Scandium-44	100
Scandium-44m	100
Scandium-46	10
Scandium-47	100
Scandium-48	100
Scandium-49	1,000
Selenium-70	1,000
Selenium-73	100
Selenium-73m	1,000
Selenium-75	100
Selenium-79	100
Selenium-81	1,000
Selenium-81m	1,000
Selenium-83	1,000
Silicon-31	1,000
Silicon-32	1
Silver-102	1,000
Silver-103	1,000
Silver-104	1,000
Silver-104m	1,000
Silver-105	100
Silver-106	1,000

Radionuclide	Quantity*(μ Ci)
Silver-106m	100
Silver-108m	1
Silver-111	100
Silver-112	100
Silver-115	1,000
Silver-110m	10
Sodium-22	10
Sodium-24	100
Strontium-80	100
Strontium-81	1,000
Strontium-83	100
Strontium-85	100
Strontium-85m	1,000
Strontium-87m	1,000
Strontium-89	10
Strontium-90	0.1
Strontium-91	100
Strontium-92	100
Sulfur-35	100
Tantalum-172	1,000
Tantalum-173	1,000
Tantalum-174	1,000
Tantalum-175	1,000
Tantalum-176	100
Tantalum-177	1,000
Tantalum-178	1,000
Tantalum-179	100
Tantalum-180	100
Tantalum-180m	1,000
Tantalum-182	10
Tantalum-182m	1,000
Tantalum-183	100
Tantalum-184	100
Tantalum-185	1,000
Tantalum-186	1,000
Technetium-93	1,000
Technetium-93m	1,000
Technetium-94	1,000
Technetium-94m	1,000
Technetium-96	100
Technetium-96m	1,000
Technetium-97	1,000
Technetium-97m	100
Technetium-98	10
Technetium-99	100
Technetium-99m	1,000
Technetium-101	1,000
Technetium-104	1,000
Tellurium-116	1,000

Radionuclide	Quantity*(μ Ci)
Tellurium-121	100
Tellurium-121m	10
Tellurium-123	100
Tellurium-123m	10
Tellurium-125m	10
Tellurium-127	1,000
Tellurium-127m	10
Tellurium-129	1,000
Tellurium-129m	10
Tellurium-131	100
Tellurium-131m	10
Tellurium-132	10
Tellurium-133	1,000
Tellurium-133m	100
Tellurium-134	1,000
Terbium-147	1,000
Terbium-149	100
Terbium-150	1,000
Terbium-151	100
Terbium-153	1,000
Terbium-154	100
Terbium-155	1,000
Terbium-156	100
Terbium-156m (24.4h)	1,000
Terbium-156m (5.0h)	1,000
Terbium-157	10
Terbium-158	1
Terbium-160	10
Terbium-161	100
Thallium-194	1,000
Thallium-194m	1,000
Thallium-195	1,000
Thallium-197	1,000
Thallium-198	1,000
Thallium-198m	1,000
Thallium-199	1,000
Thallium-200	1,000
Thallium-201	1,000
Thallium-202	100
Thallium-204	100
Thorium-226	10
Thorium-227	0.01
Thorium-228	0.001
Thorium-229	0.001
Thorium-230	0.001
Thorium-231	100
Thorium-232	100
Thorium-234	10
Thorium-natural	100

Radionuclide	Quantity*(μ Ci)
Thulium-162	1,000
Thulium-166	100
Thulium-167	100
Thulium-170	10
Thulium-171	10
Thulium-172	100
Thulium-173	100
Thulium-175	1,000
Tin-110	100
Tin-111	1,000
Tin-113	100
Tin-117m	100
Tin-119m	100
Tin-121	1,000
Tin-121m	100
Tin-123	10
Tin-123m	1,000
Tin-125	10
Tin-126	10
Tin-127	1,000
Tin-128	1,000
Titanium-44	1
Titanium-45	1,000
Tungsten-176	1,000
Tungsten-177	1,000
Tungsten-178	1,000
Tungsten-179	1,000
Tungsten-181	1,000
Tungsten-185	100
Tungsten-187	100
Tungsten-188	10
Uranium-230	0.01
Uranium-231	100
Uranium-232	0.001
Uranium-233	0.001
Uranium-234	0.001
Uranium-235	0.001
Uranium-236	0.001
Uranium-237	100
Uranium-238	100
Uranium-239	1,000
Uranium-240	100
Uranium-natural	100
Vanadium-47	1,000
Vanadium-48	100
Vanadium-49	1,000
Xenon-120	1,000
Xenon-121	1,000
Xenon-122	1,000

Radionuclide	Quantity*(μ Ci)
Xenon-123	1,000
Xenon-125	1,000
Xenon-127	1,000
Xenon-129m	1,000
Xenon-131m	1,000
Xenon-133	1,000
Xenon-133m	1,000
Xenon-135	1,000
Xenon-135m	1,000
Xenon-138	1,000
Ytterbium-162	1,000
Ytterbium-166	100
Ytterbium-167	1,000
Ytterbium-169	100
Ytterbium-175	100
Ytterbium-177	1,000
Ytterbium-178	1,000
Yttrium-86	100
Yttrium-86m	1,000
Yttrium-87	100
Yttrium-88	10
Yttrium-90	10
Yttrium-90m	1,000
Yttrium-91	10
Yttrium-91m	1,000
Yttrium-92	100
Yttrium-93	100
Yttrium-94	1,000
Yttrium-95	1,000
Zinc-62	100
Zinc-63	1,000
Zinc-65	10
Zinc-69	1,000
Zinc-69m	100
Zinc-71m	1,000
Zinc-72	100
Zirconium-86	100
Zirconium-88	10
Zirconium-89	100
Zirconium-93	1
Zirconium-95	10
Zirconium-97	100

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

0.001

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

0.01

Note: For purposes of WAC 246 221 120(8), 246 221 130 (7)(a), and 246 221 240(1) where there is involved a combination of radionuclides in known amounts, the limit for the combination shall 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.

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 WAC 246-221-290, 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 E+9 years, except rhenium, 37 MBq (1,000 μ Ci), to take into account their low specific activity.

* To convert μ Ci to kBq, multiply the μ Ci value by 37.

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-221-300, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-221-300, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70 040. WSR 91-02-049 (Order 121), recodified as § 246-221-300, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-24-230, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-24-230, filed 12/8/80; Order 1095, § 402-24-230, filed 2/6/76; Order 708, § 402-24-230, filed 8/24/72; Order 1, § 402-24-230, filed 7/2/71; Order 1, § 402-24-230, filed 1/8/69; Rules (part), filed 10/26/66.]

Chapter 246-231 WAC

PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIAL

Last Update: 12/12/16

WAC

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246-231-200 Appendix A—Determination of A1 and A2.

DISPOSITION OF SECTIONS FORMERLY CODIFIED IN THIS CHAPTER

246-231-070 Previously approved package. [Statutory Authority: RCW 70.98.050. WSR 99-15-105, § 246-231-070, filed 7/21/99, effective 8/21/99.] Repealed by WSR 08-09-093, filed 4/18/08, effective 5/19/08. Statutory Authority: RCW 70.98.050.

246-231-080 General license—DOT specification container. [Statutory Authority: RCW 70.98.050. WSR

08-09-093, § 246-231-080, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-080, filed 7/21/99, effective 8/21/99.] Repealed by WSR 14-09-017, filed 4/7/14, effective 5/8/14. Statutory Authority: RCW 70.98.050.

WAC 246-231-001 Purpose and scope. (1) This chapter establishes requirements for packaging, preparation for shipment, and transportation of radioactive material.

(2) Licensees shall also comply with applicable requirements of NRC, DOT, the United States Postal Service¹, and other requirements of Title 246 WAC.

(3) The regulations in this chapter apply to any licensee authorized by specific or general license issued by the department, NRC or an agreement state, to receive, possess, use, or transfer licensed material, if the licensee delivers that material to a carrier for transport, transports the material outside the site of usage as specified in the license, or transports that material on public highways. No provision of this chapter authorizes possession of licensed material.

¹ *Mailing Standards of the United States Postal Service, Domestic Mail Manual*, 39 C.F.R. 111.1.

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-001, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-001, filed

4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-001, filed 7/21/99, effective 8/21/99.]

WAC 246-231-005 Requirement for license. No licensee shall deliver radioactive material to a carrier for transport, or transport radioactive material, except as authorized in a general or specific license issued by the department, NRC or an agreement state, or as exempted in this chapter.

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-005, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-005, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-005, filed 7/21/99, effective 8/21/99.]

WAC 246-231-010 Definitions, abbreviations, and acronyms. The definitions, abbreviations, and acronyms in this section and in WAC 246-220-010 apply throughout this chapter unless the context clearly indicates otherwise. To ensure compatibility with international transportation standards, all limits in this chapter are given in terms of dual units: The International System of Units (SI) followed or preceded by U.S. standard or customary units. The U.S. customary units are not exact equivalents, but are rounded to a convenient value, provid-

ing a functionally equivalent unit. For the purpose of this chapter, either unit may be used.

(1) "A1" means the maximum activity of special form radioactive material permitted in a Type A package. This value is either listed in WAC 246-231-200, Table A-1 or may be derived in accordance with the procedures prescribed in WAC 246-231-200.

(2) "A2" means the maximum activity of radioactive material, other than special form material, LSA and SCO material, permitted in a Type A package. This value is either listed in WAC 246-231-200, Table A-1, or may be derived in accordance with the procedure prescribed in WAC 246-231-200.

(3) "Carrier" means a person engaged in the transportation of passengers or property by land or water as a common, contract, or private carrier, or by civil aircraft.

(4) "Certificate holder" means a person who has been issued a certificate of compliance or other package approval by NRC.

(5) "Certificate of compliance" means the certificate issued by NRC under 10 C.F.R. 71 Subpart D which approves the design of a package for the transportation of radioactive material.

(6) "Close reflection by water" means immediate contact by water of sufficient thickness for maximum reflection of neutrons.

(7) "Consignment" means each shipment of a package or groups of packages or load of radioactive material offered by a shipper for transport.

(8) "Containment system" means the assembly of components of the packaging intended to retain the radioactive material during transport.

(9) "Contamination" means the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm²(1x10⁻⁵ µCi/cm²) for beta and gamma emitters and low toxicity alpha emitters, or 0.04 Bq/cm²(1x10⁻⁶ µCi/cm²) for all other alpha emitters.

(a) Fixed contamination means contamination that cannot be removed from a surface during normal conditions of transport.

(b) Nonfixed contamination means contamination that can be removed from a surface during normal conditions of transport.

(10) "Conveyance" means:

(a) For transport by public highway or rail any transport vehicle or large freight container;

(b) For transport by water any vessel, or any hold, compartment, or defined deck area of a vessel including any transport vehicle on board the vessel; and

(c) For transport by any aircraft.

(11) "Criticality safety index (CSI)" means the dimensionless number (rounded up to the next tenth) assigned to and placed on the label of a fissile material package, to designate the degree of control of accumulation of packages, overpacks, or freight containers containing fissile material during transportation. Determination of the criticality safety index is described in WAC 246-231-094, 246-231-096, and 10 C.F.R. 71.22, 71.23, and 71.59. The criticality safety index for an overpack, freight container, consignment, or conveyance containing fissile material packages is the arithmetic sum of the criticality safety indices of all the fissile material packages contained within the overpack, freight container, consignment, or conveyance.

(12) "Deuterium" means, for the purposes of WAC 246-231-040 and 246-231-094, deuterium and any deuterium compounds, including heavy water, in which the ratio of deuterium atoms to hydrogen atoms exceeds 1:5000.

(13) "DOT" means the United States Department of Transportation. DOT regulations are found in Code of Federal Regulations Title 49 Transportation.

(14) "Exclusive use" means the sole use by a single consignor of a conveyance for which all initial, intermediate, and final loading

and unloading are carried out in accordance with the direction of the consignor or consignee. The consignor and the carrier must ensure that any loading or unloading is performed by personnel having radiological training and resources appropriate for safe handling of the consignment. The consignor must issue specific instructions, in writing, for maintenance of exclusive use shipment controls, and include them with the shipping paper information provided to the carrier by the consignor.

(15) "Fissile material" means the radionuclides uranium-233, uranium-235, plutonium-239, and plutonium-241, or any combination of these radionuclides. Fissile material means the fissile nuclides themselves, not material containing fissile nuclides. Unirradiated natural uranium and depleted uranium, and natural uranium or depleted uranium that has been irradiated in thermal reactors only are not included in this definition. Certain exclusions from fissile material controls are provided in WAC 246-231-040.

(16) "Graphite" means graphite with a boron equivalent content less than 5 parts per million and density greater than 1.5 grams per cubic centimeter.

(17) "Indian Tribe" means an Indian or Alaskan native Tribe, band, nation, pueblo, village, or community that the Secretary of the

Interior acknowledges to exist as an Indian Tribe pursuant to the Federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. 479a. A current listing of officially recognized Indian Tribes may be found at: <http://www.bia.gov/cs/groups/mywcsp/documents/text/idc-020733.pdf>.

(18) "Low specific activity (LSA) material" means radioactive material with limited specific activity which is nonfissile or is excepted under WAC 246-231-040 or 10 C.F.R. 71.15 and which satisfies the descriptions and limits set forth below. Shielding materials surrounding the LSA material may not be considered in determining the estimated average specific activity of the package contents. LSA material must be in one of three groups:

(a) LSA-I.

(i) Uranium and thorium ores, concentrates of uranium and thorium ores, and other ores containing naturally occurring radioactive radionuclides which are intended to be processed for the use of these radionuclides;

(ii) Natural uranium, depleted uranium, natural thorium, or their compounds or mixtures, provided they are unirradiated and in solid or liquid form; or

(iii) Radioactive material other than fissile material for which the A2 value is unlimited; or

(iv) Other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the value for exempt material activity concentration determined in accordance with Appendix A.

(b) LSA-II.

(i) Water with tritium concentration up to 0.8 TBq/liter (20.0 Ci/liter); or

(ii) Other radioactive material in which the activity is distributed throughout, and the estimated average specific activity does not exceed 1×10^{-4} A2/g for solids and gases, and 1×10^{-5} A2/g for liquids.

(c) LSA-III. Solids (e.g., consolidated wastes, activated materials), excluding powders, that satisfy the requirements of the 10 C.F.R. 71.77, in which:

(i) The radioactive material is distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.); and

(ii) The radioactive material is relatively insoluble, or it is intrinsically contained in a relatively insoluble material, so that, even under loss of packaging, the loss of radioactive material per

package by leaching, when placed in water for seven days, would not exceed 0.1 A2; and

(iii) The estimated average specific activity of the solid, excluding any shielding material, does not exceed 2×10^{-3} A2/g.

(19) "Low toxicity alpha emitters" means natural uranium, depleted uranium, natural thorium; uranium-235, uranium-238, thorium-232, thorium-228 or thorium-230 when contained in ores or physical or chemical concentrates or tailings; or alpha emitters with a half-life of less than ten days.

(20) "Maximum normal operating pressure" means the maximum gauge pressure that would develop in the containment system in a period of one year under the heat condition specified in NRC regulations 10 C.F.R. 71.71 (c)(1), in the absence of venting, external cooling by an ancillary system, or operational controls during transport.

(21) "Natural thorium" means thorium with the naturally occurring distribution of thorium isotopes (essentially 100 weight percent thorium-232).

(22) "Normal form radioactive material" means radioactive material that has not been demonstrated to qualify as "special form radioactive material."

(23) "Nuclear waste" as used in WAC 246-231-140 means any quantity of radioactive material (not including radiography sources being returned to the manufacturer) required to be in Type B packaging while transported to, through, or across state boundaries to a disposal site, or to a collection point for transport to a disposal site. Nuclear waste, as used in these regulations, is a special classification of radioactive waste.

(24) "Optimum interspersed hydrogenous moderation" means the presence of hydrogenous material between packages to such an extent that the maximum nuclear reactivity results.

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

(a) "Fissile material package" or Type AF package, Type BF package, Type B(U)F package or Type B(M)F package means a fissile material packaging together with its fissile material contents.

(b) "Type A package" means a Type A packaging together with its radioactive contents. A Type A package is defined and must comply with the DOT regulations in 49 C.F.R. 173.

(c) "Type B package" means a Type B packaging together with its radioactive contents. Upon approval by NRC, a Type B package design is designated by NRC as B(U) unless the package has a maximum normal op-

erating pressure of more than 700 kPa (100 lbs/in²) gauge or a pressure relief device that would allow the release of radioactive material to the environment under the tests specified in NRC regulations 10 C.F.R. 71.73 (hypothetical accident conditions), in which case it will receive a designation B(M). B(U) refers to the need for unilateral approval of international shipments; B(M) refers to the need for multi-lateral approval of international shipments. There is no distinction made in how packages with these designations may be used in domestic transportation. To determine their distinction for international transportation, see DOT regulations in 49 C.F.R. 173. A Type B package approved before September 6, 1983, was designated only as Type B. Limitations on its use are specified in 10 C.F.R. 71.19.

(26) "Packaging" means the assembly of components necessary to ensure compliance with the packaging requirements of this chapter. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle, tie-down system, and auxiliary equipment may be designated as part of the packaging.

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

(a) It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule;

(b) The piece or capsule has at least one dimension not less than 5 mm (0.2 in); and

(c) It satisfies the requirements of 10 C.F.R. 71.75. A special form encapsulation designed in accordance with the requirements of 10 C.F.R. 71.4 in effect on June 30, 1983, (see 10 C.F.R. 71, revised as of January 1, 1983), and constructed before July 1, 1985; a special form encapsulation designed in accordance with the requirements of 10 C.F.R. 71.4 in effect on March 31, 1996 (see 10 C.F.R. 71, revised as of January 1, 1996), and constructed before April 1, 1998; and special form material that was successfully tested before September 10, 2015, in accordance with the requirements of 10 C.F.R. 71.75(d) in effect before September 10, 2015, may continue to be used. Any other special form encapsulation must meet the specifications of this definition.

(28) "Specific activity of a radionuclide" means the radioactivity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the radioactivity per unit mass of the material.

(29) "Spent nuclear fuel" or "spent fuel" means fuel that has been withdrawn from a nuclear reactor following irradiation, has un-

dergone at least one year's decay since being used as a source of energy in a power reactor, and has not been chemically separated into its constituent elements by reprocessing. Spent fuel includes the special nuclear material, by-product material, source material, and other radioactive materials associated with fuel assemblies.

(30) "State" means a state of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands.

(31) "Surface contaminated object (SCO)" means a solid object that is not itself classed as radioactive material, but which has radioactive material distributed on any of its surfaces. SCO must be in one of two groups with surface activity not exceeding the following limits:

(a) SCO-I: A solid object on which:

(i) The nonfixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 4 Bq/cm² (1×10^{-4} microcurie/cm²) for beta and gamma and low toxicity alpha emitters, or 0.4 Bq/cm² (1×10^{-5} microcurie/cm²) for all other alpha emitters;

(ii) The fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not

exceed 4×10^4 Bq/cm² (1.0 microcurie/cm²) for beta and gamma and low toxicity alpha emitters, or 4×10^3 Bq/cm² (0.1 microcurie/cm²) for all other alpha emitters; and

(iii) The nonfixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 4×10^4 Bq/cm² (1 microcurie/cm²) for beta and gamma and low toxicity alpha emitters, or 4×10^3 Bq/cm² (0.1 microcurie/cm²) for all other alpha emitters.

(b) SCO-II: A solid object on which the limits for SCO-I are exceeded and on which:

(i) The nonfixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 400 Bq/cm² (1×10^{-2} microcurie/cm²) for beta and gamma and low toxicity alpha emitters or 40 Bq/cm² (1×10^{-3} microcurie/cm²) for all other alpha emitters;

(ii) The fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 8×10^5 Bq/cm² (20 microcuries/cm²) for beta and gamma and low toxicity alpha emitters, or 8×10^4 Bq/cm² (2 microcuries/cm²) for all other alpha emitters; and

(iii) The nonfixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 8x10⁵ Bq/cm² (20 microcuries/cm²) for beta and gamma and low toxicity alpha emitters, or 8x10⁴ Bq/cm² (2 microcuries/cm²) for all other alpha emitters.

(32) "Transport index (TI)" means the dimensionless number (rounded up to the next tenth) placed on the label of a package, to designate the degree of control to be exercised by the carrier during transportation. The transport index is the number determined by multiplying the maximum radiation level in millisievert (mSv) per hour at 1 meter (3.3 ft) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at 1 meter (3.3 ft)).

(33) "Tribal official" means the highest ranking individual who represents Tribal leadership, such as the chief, president, or Tribal council leadership.

(34) "Type A quantity" means a quantity of radioactive material, the aggregate radioactivity of which does not exceed A1 for special form radioactive material, or A2 for normal form radioactive material, where A1 and A2 are given in Table A-1 of WAC 246-231-200, or may be determined by procedures described in WAC 246-231-200.

(35) "Type B quantity" means a quantity of radioactive material greater than a Type A quantity.

(36) "Unirradiated uranium" means uranium containing not more than 2×10^3 Bq of plutonium per gram of uranium-235, not more than 9×10^6 Bq of fission products per gram of uranium-235, and not more than 5×10^{-3} g of uranium-236 per gram of uranium-235.

(37) Uranium-natural, depleted, enriched.

(a) "Natural uranium" means uranium (which may be chemically separated) with the naturally occurring distribution of uranium isotopes (approximately 0.711 weight percent uranium-235, and the remainder by weight essentially uranium-238).

(b) "Depleted uranium" means uranium containing less uranium-235 than the naturally occurring distribution of uranium isotopes.

(c) "Enriched uranium" means uranium containing more uranium-235 than the naturally occurring distribution of uranium isotopes.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-010, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-010, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-010, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-010, filed 7/21/99, effective 8/21/99.]

WAC 246-231-030 Transportation of licensed material. (1) Each licensee who transports licensed material outside the site of usage, as specified in the license issued by the department, NRC or an agreement state, or where transport is on public highways, or who delivers licensed material to a carrier for transport, shall comply with the applicable requirements of the DOT regulations in 49 C.F.R. 107, 171 through 180, and 390 through 397, appropriate to the mode of transport.

(a) The licensee shall particularly note DOT regulations in the following areas:

(i) Packaging—49 C.F.R. 173: Subparts A, B, and I.

(ii) Marking and labeling—49 C.F.R. 172: Subpart D, 172.400 through 172.407; and Subpart E, 172.436 through 172.441.

(iii) Placarding—49 C.F.R. 172: Subpart F, especially 172.500 through 172.519 and 172.556, and appendices B and C.

(iv) Accident reporting—49 C.F.R. 171.15 and 171.16.

(v) Shipping papers and emergency information—49 C.F.R. 172: Subparts C and G.

(vi) Hazardous material employee training—49 C.F.R. 172: Subpart H.

(vii) Security plans—49 C.F.R. 172: Subpart I.

(viii) Hazardous material shipper/carrier registration—49 C.F.R.

107: Subpart G.

(b) The licensee shall also note DOT regulations pertaining to the following modes of transportation:

(i) Rail—49 C.F.R. 174: Subparts A through D and K.

(ii) Air—49 C.F.R. 175.

(iii) Vessel—49 C.F.R. 176: Subparts A through F and M.

(iv) Public Highway—49 C.F.R. 177 and 390 through 397.

(2) If DOT regulations are not applicable to a shipment of licensed material, the licensee shall conform to the standards and requirements of the DOT specified in subsection (1) of this section to the same extent as if the shipment or transportation were subject to DOT regulations. A request for modification, waiver, or exemption from those requirements, and any notification referred to in those requirements, must be filed with, or made to, the Director, Office of Nuclear Material Safety and Safeguards, NRC, Washington, D.C. 20555-0001.

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-030, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-030, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-030, filed 7/21/99, effective 8/21/99.]

WAC 246-231-035 Deliberate misconduct. (1) For the purpose of this chapter, deliberate misconduct by a person means an intentional act or omission that the person knows:

(a) Would constitute a violation of a requirement, procedure, instruction, contract, purchase order, or policy; or

(b) Causes or would cause, if not detected, a violation of any rule, regulation, or order; or any term, condition, or limitation of any license or certificate issued by the department.

(2) This section applies to any:

(a) Licensee;

(b) Certificate holder;

(c) Quality assurance program approval holder;

(d) Applicant for a license, certificate, or quality assurance program approval;

(e) Contractor (including a supplier or consultant) or subcontractor, to any person identified in (d) of this subsection; or

(f) Employee of any person identified in (a) through (e) of this subsection.

(3) A person subject to this section who knowingly provides any components, materials, or other goods or services that relate to any activities subject to these regulations may not:

(a) Engage in deliberate misconduct; or

(b) Deliberately submit to the department or to a person subject to this section information that the person knows to be incomplete or inaccurate in some respect that matters to the department.

(4) A person who violates subsection (3)(a) or (b) of this section may be subject to enforcement action in accordance with the procedures in 10 C.F.R. 2 Subpart B.

[Statutory Authority: RCW 70.98.050. WSR 11-03-068, § 246-231-035, filed 1/18/11, effective 2/18/11; WSR 08-09-093, § 246-231-035, filed 4/18/08, effective 5/19/08.]

WAC 246-231-040 Exemptions. (1) Common and contract carriers, freight forwarders, warehouse workers, and the U.S. Postal Service are exempt from this chapter and chapters 246-232, 246-233, 246-235, 246-237, 246-240, 246-243, and 246-244 WAC to the extent that they transport or store radioactive material in the regular course of their carriage for another or storage incident thereto.

(2) Any licensee who delivers radioactive material to a carrier for transport, where such transport is subject to the regulations of the United States Postal Service, is exempt from the provisions of WAC 246-231-005.

(3) **Exemption of physicians.** Any physician as defined in WAC 246-220-010 who is licensed by the department, NRC or an agreement state, to dispense drugs in the practice of medicine, is exempt from WAC 246-220-030 with respect to transport by the physician of licensed material for use in the practice of medicine. However, any physician operating under this exemption must be licensed under chapter 246-240 WAC, 10 C.F.R. 35, or the equivalent agreement state regulations.

(4) **Exemption for low-level materials.** A licensee is exempt from all requirements of this chapter with respect to shipment or carriage of the following low-level materials:

(a) Natural material and ores containing naturally occurring radionuclides that are either in their natural state, or have only been processed for purposes other than for the extraction of the radionuclides, and which are not intended to be processed for use of these radionuclides, provided the activity concentration of the material does not exceed ten times the applicable radionuclide activity concentration values specified in WAC 246-231-200, Table A-2 or Table A-3.

(b) Materials for which the activity concentration is not greater than the activity concentration values specified in WAC 246-231-200, Table A-2 or Table A-3, or for which the consignment activity is not

greater than the limit for an exempt consignment found in WAC 246-231-200, Table A-2 or Table A-3.

(c) Nonradioactive solid objects with radioactive substances present on any surfaces in quantities not in excess of the levels cited in the definition of contamination in WAC 246-231-010.

(5) A licensee is exempt from all the requirements of this chapter, other than 10 C.F.R. 71.5 and 71.88, with respect to shipment or carriage of the following packages, provided the packages do not contain any fissile material, or the material is exempt from classification as fissile material in this subsection;

(a) A package that contains no more than a Type A quantity of radioactive material;

(b) A package transported within the United States that contains no more than 0.74 TBq (20 Ci) of special form plutonium-244; or

(c) The package contains only LSA or SCO radioactive material, provided:

(i) That the LSA or SCO material has an external radiation dose of less than or equal to 10 mSv/h (1 rem/h), at a distance of three meters from the unshielded material; or

(ii) That the package contains only LSA-I or SCO-I material.

(6) **Exemption from classification as fissile material.** Fissile material meeting at least one of the requirements in (a) through (f) of this subsection is exempt from classification as fissile material and from the fissile material package standards of 10 C.F.R. 71.55 and 71.59, but are subject to all other requirements of this chapter, except as noted.

(a) Individual package containing 2 grams or less fissile material.

(b) Individual or bulk packaging containing 15 grams or less of fissile material provided the package has at least 200 grams of solid nonfissile material for every gram of fissile material. Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package but must not be included in determining the required mass for solid nonfissile material.

(c)(i) Low concentrations of solid fissile material commingled with solid nonfissile material, provided that:

(A) There are at least 2000 grams of solid nonfissile material for every gram of fissile material; and

(B) There are no more than 180 grams of fissile material distributed within 360 kg of contiguous nonfissile material.

(ii) Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package but must not be included in determining the required mass of solid nonfissile material.

(d) Uranium enriched in uranium-235 to a maximum of 1 percent by weight, and with total plutonium and uranium-233 content of up to 1 percent of the mass of uranium-235, provided that the mass of any beryllium, graphite, and hydrogenous material enriched in deuterium constitutes less than 5 percent of the uranium mass, and that the fissile material is distributed homogeneously and does not form a lattice arrangement within the package.

(e) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2 percent by mass, with a total plutonium and uranium-233 content not exceeding 0.002 percent of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2. The material must be contained in at least a DOT Type A package.

(f) Packages containing, individually, a total plutonium mass of not more than 1000 grams, of which not more than 20 percent by mass may consist of plutonium-239, plutonium-241, or any combination of these radionuclides.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-040, filed 12/12/16, effective 1/12/17; WSR 16-13-054, § 246-

231-040, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-040, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-040, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-040, filed 7/21/99, effective 8/21/99.]

WAC 246-231-050 General licenses for carriers. (1) A general license is hereby issued to any common or contract carrier not exempted under WAC 246-231-040 to receive, possess, transport and store radioactive material in the regular course of their carriage for another or storage incident thereto, provided the transportation and storage is in accordance with the applicable requirements of the regulations, appropriate to the mode of transport, of the United States Department of Transportation.

(2) A general license is hereby issued to any private carrier to transport radioactive material, provided the transportation is in accordance with the applicable requirements of the regulations, appropriate to the mode of transport, of the United States Department of Transportation insofar as such regulations relate to the loading and storage of packages, placarding of the transporting vehicle, shipping papers, and incident reporting. Any notification of incidents referred

to in those requirements shall be filed with, or made to, the department.

(3) Persons who transport radioactive material pursuant to the general licenses of subsection (1) or (2) of this section are exempt from the requirements of chapters 246-221 and 246-222 WAC to the extent that they transport radioactive material.

(4) A general license is hereby issued to deliver radioactive material to a carrier¹ for transport provided that:

(a) The licensee complies with the applicable requirements of the regulations, appropriate to the mode of transport, of the United States Department of Transportation insofar as such regulations relate to the packaging of radioactive material, to shipping papers, and to the monitoring, marking and labeling of those packages.

(b) The licensee has established procedures for opening and closing packages in which radioactive material is transported to provide safety and to assure that, prior to the delivery to a carrier for transport, each package is properly closed for transport.

(c) Prior to delivery of a package to a carrier for transport, the licensee shall assure that any special instructions needed to safely open the package are sent to or have been made available to the consignee.

(d) In addition to the requirements of the United States Department of Transportation, each package of Type A or B quantity radioactive material prepared for shipment must have the innermost container labeled as to the isotope, chemical form, number of becquerels or sub-units thereof, and date of determination of activity and each innermost container shall be tested to assure that the container is properly sealed and that contamination which would cause undue hazard to public health and safety or property is not present prior to transportation. This requirement does not apply to properly packaged shipments of radioactive waste consigned to a commercial low level radioactive waste disposal facility.

¹ For the purpose of this regulation, licensees who transport their own licensed material as a private carrier are considered to have delivered such material to a carrier for transport.

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-050, filed 4/7/14, effective 5/8/14; WSR 99-15-105, § 246-231-050, filed 7/21/99, effective 8/21/99.]

WAC 246-231-060 General license—NRC-approved package. (1) A general license is hereby issued to any licensee of the department, NRC, or an agreement state, to transport, or to deliver to a carrier for transport, licensed material in a package for which a license, certificate of compliance, or other approval has been issued by the NRC.

(2) This general license applies only to a licensee who has a quality assurance program approved by NRC as satisfying the provisions of 10 C.F.R. 71 Subpart H.

(3) Each licensee issued a general license under this chapter shall:

(a) Maintain a copy of the certificate of compliance, or other approval of the package, and the drawings and other documents referenced in the approval relating to the use and maintenance of the packaging and to the actions to be taken before shipment;

(b) Comply with the terms and conditions of the license, certificate, or other approval, as applicable, and the applicable requirements of 10 C.F.R. 71 Subparts A, G, and H; and

(c) Before the licensee's first use of the package, submits in writing to: ATTN: Document Control Desk, Director, Division of Spent Fuel Storage and Transportation, Office of Nuclear Material Safety and Safeguards, using an appropriate method listed in 10 C.F.R. 71.1(a), the licensee's name and license number and the package identification number specified in the package approval.

(4) This general license applies only when the package approval authorizes use of the package under this general license.

(5) For a Type B or fissile material package, the design of which was approved by NRC before April 1, 1996, the general license is subject to the additional restrictions of 10 C.F.R. 71.19.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-060, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-060, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-060, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-060, filed 7/21/99, effective 8/21/99.]

WAC 246-231-090 General license—Use of foreign approved package.

(1) A general license is issued to any licensee of the department, NRC, or an agreement state, to transport, or to deliver to a carrier for transport, licensed material in a package the design of which has been approved in a foreign national competent authority certificate that has been revalidated by DOT as meeting the applicable requirements of 49 C.F.R. 171.23.

(2) Except as otherwise provided in this chapter, the general license applies only to a licensee who has a quality assurance program approved by NRC as satisfying the applicable provisions of 10 C.F.R. 71 Subpart H.

(3) This general license applies only to shipments made to or from locations outside the United States.

(4) Each licensee issued a general license under this section shall:

(a) Maintain a copy of the applicable certificate, the revalidation, and the drawings and other documents referenced in the certificate, relating to the use and maintenance of the packaging and to the actions to be taken before shipment; and

(b) Comply with the terms and conditions of the certificate and revalidation, and with the applicable requirements of 10 C.F.R. 71 Subparts A, G, and H.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-090, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-090, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-090, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-090, filed 7/21/99, effective 8/21/99.]

WAC 246-231-094 General license—Fissile material. (1) A general license is issued to any licensee of the department, NRC, or an agreement state, to transport fissile material, or to deliver fissile mate-

rial to a carrier for transport, if the material is shipped in accordance with this section. The fissile material need not be contained in a package which meets the standards of 10 C.F.R. 71 Subparts E and F; however, the material must be contained in a Type A package. The Type A package must also meet the DOT requirements of 49 C.F.R. 173.417(a).

(2) The general license applies only to a licensee who has a quality assurance program approved by NRC as satisfying the provisions of 10 C.F.R. 71 Subpart H.

(3) The general license applies only when a package's contents:

(a) Contain no more than a Type A quantity of radioactive material; and

(b) Contain less than 500 total grams of beryllium, graphite, or hydrogenous material enriched in deuterium.

(4) The general license applies only to packages containing fissile material that are labeled with a CSI which:

(a) Has been determined in accordance with subsection (5) of this section;

(b) Has a value less than or equal to 10; and

(c) For a shipment of multiple packages containing fissile material, the sum of the CSIs must be less than or equal to 50 (for ship-

ment on a nonexclusive use conveyance) and less than or equal to 100 (for shipment on an exclusive use conveyance).

(5)(a) The value for the CSI must be greater than or equal to the number calculated by the following equation:

$$CSI = 10 \left[\frac{\text{grams of } ^{235}\text{U}}{X} + \frac{\text{grams of } ^{233}\text{U}}{Y} + \frac{\text{grams of Pu}}{Z} \right]$$

(b) The calculated CSI must be rounded up to the first decimal place;

(c) The values of X, Y, and Z used in the CSI equation must be taken from WAC 246-231-200 Table-1 or Table-2, as appropriate;

(d) If Table-2 is used to obtain the value of X, then the values for the terms in the equation for uranium-233 and plutonium must be assumed to be zero; and

(e) Values from Table-1 for X, Y, and Z must be used to determine the CSI if:

(i) Uranium-233 is present in the package;

(ii) The mass of plutonium exceeds 1 percent of the mass of uranium-235;

(iii) The uranium is of unknown uranium-235 enrichment or greater than 24 weight percent enrichment; or

(iv) Substances having a moderating effectiveness (i.e., an average hydrogen density greater than H₂O) (e.g., certain hydrocarbon oils or plastics) are present in any form, except as polyethylene used for packing or wrapping.

Table-1.
Mass Limits for General License Packages
Containing Mixed Quantities of Fissile Material or Uranium-235 of Unknown Enrichment
per WAC 246-231-094(5)

Fissile material	Fissile material mass mixed with moderating substances having an average hydrogen density less than or equal to H₂O (grams)	Fissile material mass mixed with moderating substances having an average hydrogen density greater than H₂O^a (grams)
²³⁵ U (X)	60	38
²³³ U (Y)	43	27
²³⁹ Pu or ²⁴¹ Pu (Z)	37	24

^a When mixtures of moderating substances are present, the lower mass limits shall be used if more than 15 percent of the moderating substance has an average hydrogen density greater than H₂O.

Table-2.
Mass Limits for General License Packages
Containing Uranium-235 of Known Enrichment
per WAC 246-231-094(5)

Uranium enrichment in weight percent of ²³⁵U not exceeding	Fissile material mass of ²³⁵U (X) (grams)
24	60
20	63
15	67
11	72
10	76
9.5	78
9	81
8.5	82
8	85
7.5	88
7	90
6.5	93
6	97
5.5	102
5	108
4.5	114
4	120

Uranium enrichment in weight percent of ²³⁵ U not exceeding	Fissile material mass of ²³⁵ U (X) (grams)
3.5	132
3	150
2.5	180
2	246
1.5	408
1.35	480
1	1,020
0.92	1,800

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-094, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-094, filed 4/18/08, effective 5/19/08.]

Reviser's note: The brackets and enclosed material in the text of the above section occurred in the copy filed by the agency.

WAC 246-231-096 General license—Plutonium-beryllium special form material. (1) A general license is issued to any licensee of the department, NRC, or an agreement state, to transport fissile material in the form of plutonium-beryllium (Pu-Be) special form sealed sources, or to deliver Pu-Be sealed sources to a carrier for transport, if the material is shipped in accordance with this section. This material must be contained in a Type A package. The Type A package must also meet the DOT requirements of 49 C.F.R. 173.417(a).

(2) The general license applies only to a licensee who has a quality assurance program approved by NRC as satisfying the provisions of 10 C.F.R. 71 Subpart H.

(3) The general license applies only when a package's contents:

(a) Contain no more than a Type A quantity of radioactive material; and

(b) Contain less than 1000 g of plutonium, provided that: Plutonium-239, plutonium-241, or any combination of these radionuclides, constitutes less than 240 g of the total quantity of plutonium in the package.

(4) The general license applies only to packages labeled with a CSI which:

(a) Has been determined in accordance with subsection (5) of this section;

(b) Has a value less than or equal to 100; and

(c) For a shipment of multiple packages containing Pu-Be sealed sources, the sum of the CSIs must be less than or equal to 50 (for shipment on a nonexclusive use conveyance) and less than or equal to 100 (for shipment on an exclusive use conveyance).

(5)(a) The value for the CSI must be greater than or equal to the number calculated by the following equation:

$$\text{CSI} = 10 \left[\frac{\text{grams of } ^{239}\text{Pu} + \text{grams of } ^{241}\text{Pu}}{24} \right]; \text{ an}$$

(b) The calculated CSI must be rounded up to the first decimal place.

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-096, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-096, filed 4/18/08, effective 5/19/08.]

Reviser's note: The brackets and enclosed material in the text of the above section occurred in the copy filed by the agency.

WAC 246-231-098 External radiation standards for all packages.

(1) Except as provided in subsection (2) of this section, each package of radioactive materials offered for transportation must be designed and prepared for shipment so that under conditions normally incident to transportation the radiation level does not exceed 2 mSv/hour (200 mrem/hour) at any point on the external surface of the package, and the transport index does not exceed 10.

(2) A package that exceeds the radiation level limits specified in subsection (1) of this section must be transported by exclusive use shipment only, and the radiation levels for such shipment must not exceed the following during transportation:

(a) 2 mSv/hour (200 mrem/hour) on the external surface of the package, unless the following conditions are met, in which case the limit is 10 mSv/hour (1000 mrem/hour):

(i) The shipment is made in a closed transport vehicle;

(ii) The package is secured within the vehicle so that its position remains fixed during transportation; and

(iii) There are no loading or unloading operations between the beginning and end of the transportation;

(b) 2 mSv/hour (200 mrem/hour) at any point on the outer surface of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load or enclosure, if used, and on the lower external surface of the vehicle; and

(c) 0.1 mSv/hour (10 mrem/hour) at any point 2 meters (80 in) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2 meters (6.6 feet) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle); and

(d) 0.02 mSv/hour (2 mrem/hour) in any normally occupied space, except that this provision does not apply to private carriers, if exposed personnel under their control wear radiation dosimetry devices in conformance with WAC 246-221-090 and 246-221-100.

(3) For shipments made under the provisions of subsection (2) of this section, the shipper shall provide specific written instructions to the carrier for maintenance of the exclusive use shipment controls. The instructions must be included with the shipping paper information.

(4) The written instructions required for exclusive use shipments must be sufficient so that, when followed, they will cause the carrier to avoid actions that will unnecessarily delay delivery or unnecessarily result in increased radiation levels or radiation exposures to transport workers or members of the general public.

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-098, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-098, filed 4/18/08, effective 5/19/08.]

WAC 246-231-100 Applicability of operating controls and procedures. A licensee subject to this chapter, who, under a general or specific license, transports licensed material or delivers licensed material to a carrier for transport, shall comply with the require-

ments of 10 C.F.R. 71 Subpart G, with the quality assurance requirements of 10 C.F.R. 71 Subpart H, and with the general provisions of 10 C.F.R. 71 Subpart A.

[Statutory Authority: RCW 70.98.050. WSR 08-09-093, § 246-231-100, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-100, filed 7/21/99, effective 8/21/99.]

WAC 246-231-103 Assumptions as to unknown properties. When the isotopic abundance, mass, concentration, degree of irradiation, degree of moderation, or other pertinent property of fissile material in any package is not known, the licensee shall package the fissile material as if the unknown properties have credible values that will cause the maximum neutron multiplication.

[Statutory Authority: RCW 70.98.050. WSR 08-09-093, § 246-231-103, filed 4/18/08, effective 5/19/08.]

WAC 246-231-106 Preliminary determinations. Before the first use of any packaging for the shipment of licensed material:

(1) The licensee shall ascertain that there are no cracks, pinholes, uncontrolled voids, or other defects that could significantly reduce the effectiveness of the packaging;

(2) Where the maximum normal operating pressure will exceed 35 kPa (5 lbs/in²) gauge, the licensee shall test the containment system at an internal pressure at least fifty percent higher than the maximum normal operating pressure, to verify the capability of that system to maintain its structural integrity at that pressure;

(3) The licensee shall conspicuously and durably mark the packaging with its model number, serial number, gross weight, and a package identification number assigned by NRC. Before applying the model number, the licensee shall determine that the packaging has been fabricated in accordance with the design approved by NRC; and

(4) The licensee shall ascertain that the determinations in subsections (1) through (3) of this section have been made.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-106, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-106, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-106, filed 4/18/08, effective 5/19/08.]

WAC 246-231-110 Routine determinations. Before each shipment of licensed material, the licensee shall ensure that the package with its

contents satisfies the applicable requirements of this chapter and of the license. The licensee shall determine that:

(1) The package is proper for the contents to be shipped;

(2) The package is in unimpaired physical condition except for superficial defects such as marks or dents;

(3) Each closure device of the packaging, including any required gasket, is properly installed and secured and free of defects;

(4) Any system for containing liquid is adequately sealed and has adequate space or other specified provision for expansion of the liquid;

(5) Any pressure relief device is operable and set in accordance with written procedures;

(6) The package has been loaded and closed in accordance with written procedures;

(7) For fissile material, any moderator or neutron absorber, if required, is present and in proper condition;

(8) Any structural part of the package that could be used to lift or tie down the package during transport is rendered inoperable for that purpose, unless it satisfies the design requirements of 10 C.F.R. 71.45;

(9) The level of nonfixed (removable) radioactive contamination on the external surfaces of each package offered for shipment is as low as reasonably achievable, and within the limits specified in DOT regulations in 49 C.F.R. 173.443;

(10) External radiation levels around the package and around the vehicle, if applicable, will not exceed the limits specified in WAC 246-231-098 at any time during transportation; and

(11) Accessible package surface temperatures will not exceed the limits specified in 10 C.F.R. 71.43(g) at any time during transportation.

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-110, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-110, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-110, filed 7/21/99, effective 8/21/99.]

WAC 246-231-120 Air transport of plutonium. (1) Notwithstanding the provisions of any general licenses and notwithstanding any exemptions stated directly in this chapter or included indirectly by citation of 49 C.F.R. chapter I, as may be applicable, the licensee shall assure that plutonium in any form, whether for import, export, or do-

mestic shipment, is not transported by air or delivered to a carrier for air transport unless:

(a) The plutonium is contained in a medical device designed for individual human application; or

(b) The plutonium is contained in a material in which the specific activity is less than or equal to the activity concentration values for plutonium specified in WAC 246-231-200, Table A-2, and in which the radioactivity is essentially uniformly distributed; or

(c) The plutonium is shipped in a single package containing no more than an A2 quantity of plutonium in any isotope or form, and is shipped in accordance with WAC 246-231-030; or

(d) The plutonium is shipped in a package specifically authorized for the shipment of plutonium by air in the Certificate of Compliance for that package issued by NRC.

(2) Nothing in subsection (1) of this section is to be interpreted as removing or diminishing the requirements of NRC regulations 10 C.F.R. 73.24.

(3) For a shipment of plutonium by air which is subject to subsection (1)(d) of this section, the licensee shall, through special arrangement with the carrier, require compliance with 49 C.F.R. 175.704 DOT regulations applicable to the air transport of plutonium.

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-120, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-120, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-120, filed 7/21/99, effective 8/21/99.]

WAC 246-231-130 Opening instructions. Before delivery of a package to a carrier for transport, the licensee shall ensure that any special instructions needed to safely open the package have been sent to, or otherwise made available to, the consignee for the consignee's use in accordance with WAC 246-221-160.

[Statutory Authority: RCW 70.98.050. WSR 99-15-105, § 246-231-130, filed 7/21/99, effective 8/21/99.]

WAC 246-231-133 Public inspection of application. Applications for approval of a package design under this chapter, which are submitted to NRC, may be made available for public inspection, in accordance with provisions of 10 C.F.R. 2 and 9. This includes an application to amend or revise an existing package design, any associated documents and drawings submitted with the application, and any responses to NRC requests for additional information.

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-133, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-133, filed 4/18/08, effective 5/19/08.]

WAC 246-231-136 Records. (1) Each licensee shall maintain, for a period of three years after shipment, a record of each shipment of licensed material not exempt under WAC 246-231-040(4), showing where applicable:

(a) Identification of the packaging by model number and serial number;

(b) Verification that there are no significant defects in the packaging, as shipped;

(c) Volume and identification of coolant;

(d) Type and quantity of licensed material in each package, and the total quantity of each shipment;

(e) For each item of irradiated fissile material:

(i) Identification by model number and serial number;

(ii) Irradiation and decay history to the extent appropriate to demonstrate that its nuclear and thermal characteristics comply with license conditions; and

(iii) Any abnormal or unusual condition relevant to radiation safety;

(f) Date of the shipment;

(g) For fissile packages and for Type B packages, any special controls exercised;

(h) Name and address of the transferee;

(i) Address to which the shipment was made; and

(j) Results of the determinations required by WAC 246-231-110 and by the conditions of the package approval.

(2) The licensee, certificate holder, and an applicant for a certificate of compliance, shall make available to the department and NRC for inspection, upon reasonable notice, all records required by 10 C.F.R. 71.91. Records are only valid if stamped, initialed, or signed and dated by authorized personnel, or otherwise authenticated.

(3) The licensee, certificate holder, and an applicant for a certificate of compliance shall maintain sufficient written records to furnish evidence of the quality of packaging. The records to be maintained include results of the determinations required by WAC 246-231-106; design, fabrication, and assembly records; results of reviews, inspections, tests, and audits; results of monitoring work performance and materials analyses; and results of maintenance, modification, and

repair activities. Inspection, test, and audit records must identify the inspector or data recorder, the type of observation, the results, the acceptability, and the action taken in connection with any deficiencies noted. These records must be retained for three years after the life of the packaging to which they apply.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-136, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-136, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-136, filed 4/18/08, effective 5/19/08.]

WAC 246-231-140 Advance notification of shipment of irradiated reactor fuel and nuclear waste. (1)(a) As specified in subsections (2), (3), and (4) of this section, each licensee shall provide advance notification to the governor of a state, or the governor's designee, of the shipment of licensed material, within or across the boundary of the state, before the transport, or delivery to a carrier, for transport, of licensed material outside the confines of the licensee's plant or other place of use or storage.

(b) As specified in subsections (2), (3), and (4) of this section, after June 11, 2013, each licensee shall provide advance notifi-

cation to the Tribal official of participating tribes referenced in subsection (3)(c)(iii) of this section, or the official's designee, of the shipment of licensed material within or across the boundary of the Tribe's reservation before the transport, or delivery to a carrier for transport, of licensed material outside the confines of the licensee's plant or other place of use or storage.

(2) Advance notification is required under this section for shipments of irradiated reactor fuel in quantities less than that subject to advance notification requirements of NRC regulations 10 C.F.R. 73.37(f). Advance notification is also required under this section for shipment of licensed material, other than irradiated fuel, meeting the following three conditions:

(a) The licensed material is required by this section to be in Type B packaging for transportation;

(b) The licensed material is being transported to or across a state boundary en route to a disposal facility or to a collection point for transport to a disposal facility; and

(c) The quantity of licensed material in a single package exceeds the least of the following:

(i) 3000 times the A1 value of the radionuclides as specified in WAC 246-231-200, Table A-1 for special form radioactive material;

(ii) 3000 times the A2 value of the radionuclides as specified in WAC 246-231-200, Table A-1 for normal form radioactive material; or

(iii) 1000 TBq (27,000 Ci).

(3) Procedures for submitting advance notification.

(a) The notification must be made in writing to the office of each appropriate governor or governor's designee, to the office of each appropriate Tribal official or Tribal official's designee, and to the Director, Division of Security Policy, Office of Nuclear Security and Incident Response.

(b) A notification delivered by mail must be postmarked at least seven days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

(c) A notification delivered by any other means than mail must reach the office of the governor or the governor's designee, or of the Tribal official or the Tribal official's designee, at least four days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

(i) A list of the names and mailing addresses of the governors' designees receiving advance notification of transportation of nuclear waste was published in the *Federal Register* on June 30, 1995, (60 FR 34306).

(ii) Contact information for each state, including telephone and mailing addresses of governors and governors' designees, and participating Tribes, including telephone and mailing addresses of Tribal officials and Tribal official's designees, is available on the NRC web site at: <https://scp.nrc.gov/special/designee.pdf>.

(iii) A list of the names and mailing addresses of the governors' designees and Tribal officials' designees of participating Tribes is available on request from the Director, Division of Intergovernmental Liaison and Rulemaking, Office of Federal and State Materials and Environmental Management Programs, NRC, Washington, D.C. 20555-0001.

(d) The licensee shall retain a copy of the notification as a record for three years.

(4) Information to be furnished in advance notification of shipment. Each advance notification of shipment of irradiated reactor fuel or nuclear waste must contain the following information:

(a) The name, address, and telephone number of the shipper, carrier, and receiver of the irradiated reactor fuel or nuclear waste shipment;

(b) A description of the irradiated reactor fuel or nuclear waste contained in the shipment, as specified in the regulations of DOT in 49 C.F.R. 172.202 and 172.203(d);

(c) The point of origin of the shipment and the seven-day period during which departure of the shipment is estimated to occur;

(d) The seven-day period during which arrival of the shipment at state boundaries or Tribal reservation boundaries is estimated to occur;

(e) The destination of the shipment, and the seven-day period during which arrival of the shipment is estimated to occur; and

(f) A point of contact, with a telephone number, for current shipment information.

(5) Revision notice. A licensee who finds that schedule information previously furnished to a governor or governor's designee, or a Tribal official or Tribal official's designee, in accordance with this section, will not be met, shall telephone a responsible individual in the office of the governor of the state or of the governor's designee or the Tribal official or the Tribal official's designee, and inform that individual of the extent of the delay beyond the schedule originally reported. The licensee shall maintain a record of the name of the individual contacted for three years.

(6) Cancellation notice.

(a) Each licensee who cancels an irradiated reactor fuel or nuclear waste shipment for which advance notification has been sent

shall send a cancellation notice to the governor of each state or to the governor's designee previously notified, to each Tribal official or to the Tribal official's designee previously notified, and to the Director, Division of Security Policy, Office of Nuclear Security and Incident Response.

(b) The licensee shall state in the notice that it is a cancellation and identify the advance notification that is being canceled. The licensee shall retain a copy of the notice as a record for three years.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-140, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-140, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-140, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-140, filed 7/21/99, effective 8/21/99.]

WAC 246-231-150 Quality assurance requirements. (1) Purpose. This section describes quality assurance requirements that apply to design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, and modification of components of packaging that are important to safety. As

used in this chapter, "quality assurance" comprises all those planned and systematic actions necessary to provide adequate confidence that a system or component will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality assurance actions related to control of the physical characteristics and quality of the material or component to predetermined requirements. Each licensee and applicant for a package approval is responsible for satisfying the quality assurance requirements that apply to design, fabrication, testing, and modification of packaging subject to this chapter. Each licensee is responsible for satisfying the quality assurance requirements that apply to its use of packaging for the shipment of licensed material subject to this chapter.

(2) Establishment of program. Each licensee, certificate holder, and applicant for a certificate of compliance shall establish, maintain, and execute a quality assurance program satisfying each of the applicable criteria in 10 C.F.R. 71.101 through 71.137 and satisfying any specific provisions that are applicable to the licensee's activities including procurement of packaging. The licensee, certificate holder, and applicant for a certificate of compliance shall execute the applicable criteria in a graded approach to an extent that is com-

mensurate with the quality assurance requirement's importance to safety.

(3) Approval of program. Before the use of any package for the shipment of licensed material subject to this chapter, each licensee shall obtain NRC approval of its quality assurance program. Using an appropriate method listed in 10 C.F.R. 71.1(a), each licensee shall file a description of its quality assurance program, including a discussion of which requirements of 10 C.F.R. 71 Subpart H are applicable and how they will be satisfied, by submitting the description to: ATTN: Document Control Desk, Director, Division of Spent Fuel Management, Office of Nuclear Material Safety and Safeguards.

(4) Radiography containers. 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 WAC 246-243-120(2), 10 C.F.R. 34.31(b), or equivalent agreement state requirements, is deemed to satisfy the requirements of WAC 246-231-060(2) and 246-231-150(2).

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-150, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-150, filed 4/7/14, effective

5/8/14; WSR 08-09-093, § 246-231-150, filed 4/18/08, effective 5/19/08.]

WAC 246-231-160 Quality assurance organization. (1) The licensee, certificate holder, and applicant for a certificate of compliance shall be responsible for the establishment and execution of the quality assurance program. The licensee, certificate holder, and applicant for a certificate of compliance may delegate to others, such as contractors, agents, or consultants, the work of establishing and executing the quality assurance program, or any part of the quality assurance program, but shall retain responsibility for the program. These activities include performing the functions associated with attaining quality objectives and the quality assurance functions.

While the term "licensee" is used in these criteria, the requirements are applicable to whatever design, fabrication, assembly, and testing of the package is accomplished with respect to a package before the time a package approval is issued.

(2) The quality assurance functions are:

(a) Assuring that an appropriate quality assurance program is established and effectively executed; and

(b) Verifying, by procedures such as checking, auditing, and inspection, that activities affecting the functions that are important to safety have been correctly performed.

(3) The persons and organizations performing quality assurance functions must have sufficient authority and organizational freedom to:

- (a) Identify quality problems;
- (b) Initiate, recommend, or provide solutions; and
- (c) Verify implementation of solutions.

(4) The persons and organizations performing quality assurance functions shall report to a management level that assures that the required authority and organizational freedom, including sufficient independence from cost and schedule, when opposed to safety considerations, are provided.

(5) Because of the many variables involved, such as the number of personnel, the type of activity being performed, and the location or locations where activities are performed, the organizational structure for executing the quality assurance program may take various forms, provided that the persons and organizations assigned the quality assurance functions have the required authority and organizational freedom.

(6) Irrespective of the organizational structure, the individual(s) assigned the responsibility for assuring effective execution of any portion of the quality assurance program, at any location where

activities subject to this chapter are being performed, must have direct access to the levels of management necessary to perform this function.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-160, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 08-09-093, § 246-231-160, filed 4/18/08, effective 5/19/08.]

WAC 246-231-170 Quality assurance program. (1) The licensee, certificate holder, and applicant for a certificate of compliance shall establish, at the earliest practicable time consistent with the schedule for accomplishing the activities, a quality assurance program that complies with the requirements of 10 C.F.R. 71.101 through 71.137. The licensee, certificate holder, and applicant for a certificate of compliance shall document the quality assurance program by written procedures or instructions and shall carry out the program in accordance with those procedures throughout the period during which the packaging is used. The licensee, certificate holder, and applicant for a certificate of compliance shall identify the material and components to be covered by the quality assurance program, the major organizations par-

ticipating in the program, and the designated functions of these organizations.

(2) The licensee, certificate holder, and applicant for a certificate of compliance, through its quality assurance program, shall provide control over activities affecting the quality of the identified materials and components to an extent consistent with their importance to safety, and as necessary to assure conformance to the approved design of each individual package used for the shipment of radioactive material. The licensee, certificate holder, and applicant for a certificate of compliance shall assure that activities affecting quality are accomplished under suitably controlled conditions. Controlled conditions include the use of appropriate equipment; suitable environmental conditions for accomplishing the activity, such as adequate cleanliness; and assurance that all prerequisites for the given activity have been satisfied. The licensee, certificate holder, and applicant for a certificate of compliance shall take into account the need for special controls, processes, test equipment, tools, and skills to attain the required quality, and the need for verification of quality by inspection and test.

(3) The licensee, certificate holder, and applicant for a certificate of compliance shall base the requirements and procedures of its

quality assurance program on the following considerations concerning the complexity and proposed use of the package and its components:

(a) The impact of malfunction or failure of the item to safety;

(b) The design and fabrication complexity or uniqueness of the item;

(c) The need for special controls and surveillance over processes and equipment;

(d) The degree to which functional compliance can be demonstrated by inspection or test; and

(e) The quality history and degree of standardization of the item.

(4) The licensee, certificate holder, and applicant for a certificate of compliance shall provide for indoctrination and training of personnel performing activities affecting quality, as necessary to assure that suitable proficiency is achieved and maintained. The licensee, certificate holder, and applicant for a certificate of compliance shall review the status and adequacy of the quality assurance program at established intervals. Management of other organizations participating in the quality assurance program shall review regularly the status and adequacy of that part of the quality assurance program they are executing.

[Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-170, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-170, filed 4/18/08, effective 5/19/08.]

WAC 246-231-174 Changes to quality assurance program. (1) Each quality assurance program approval holder shall submit, in accordance with 10 C.F.R. 71.1(a), a description of a proposed change to its NRC-approved quality assurance program that will reduce commitments in the program description as approved by the NRC. The quality assurance program approval holder shall not implement the change before receiving NRC approval.

(a) The description of a proposed change to the NRC-approved quality assurance program must identify the change, the reason for the change, the basis for concluding that the revised program incorporating the change continues to satisfy the applicable requirements of 10 C.F.R. Subpart H.

(b) (Reserved.)

(2) Each quality assurance program approval holder may change a previously approved quality assurance program without prior NRC approval, if the change does not reduce the commitments in the quality assurance program previously approved by the NRC. Changes to the qual-

ity assurance program that do not reduce the commitments shall be submitted to the NRC every twenty-four months, in accordance with 10 C.F.R. 71.1(a). In addition to quality assurance program changes involving administrative improvements and clarifications, spelling corrections, and nonsubstantive changes to punctuation or editorial items, the following changes are not considered reductions in commitment:

(a) The use of a quality assurance standard approved by the NRC that is more recent than the quality assurance standard in the certificate holder's or applicant's current quality assurance program at the time of the change;

(b) The use of generic organizational position titles that clearly denote the position function, supplemented as necessary by descriptive text, rather than specific titles, provided that there is no substantive change to either the functions of the position or reporting responsibilities;

(c) The use of generic organization charts to indicate functional relationships, authorities, and responsibilities, or alternatively, the use of descriptive text, provided that there is no substantive change to the functional relationships, authorities, or responsibilities;

(d) The elimination of quality assurance program information that duplicates language in quality assurance regulatory guides and quality assurance standards to which the quality assurance program approval holder has committed to on record; and

(e) Organizational revisions that ensure that persons and organizations performing quality assurance functions continue to have the requisite authority and organizational freedom, including sufficient independence from cost and schedule when opposed to safety considerations.

(3) Each quality assurance program approval holder shall maintain records of quality assurance program changes.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-174, filed 12/12/16, effective 1/12/17.]

WAC 246-231-178 Handling, storage, and shipping control. The licensee, certificate holder, and applicant for a certificate of compliance shall establish measures to control, in accordance with instructions, the handling, storage, shipping, cleaning, and preservation of materials and equipment to be used in packaging to prevent damage or deterioration. When necessary for particular products, special protec-

tive environments, such as inert gas atmosphere, and specific moisture content and temperature levels must be specified and provided.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-178, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 08-09-093, § 246-231-178, filed 4/18/08, effective 5/19/08.]

WAC 246-231-180 Inspection, test, and operating status. (1) The licensee, certificate holder, and applicant for a certificate of compliance shall establish measures to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the packaging. These measures must provide for the identification of items that have satisfactorily passed required inspections and tests, where necessary to preclude inadvertent bypassing of the inspections and tests.

(2) The licensee shall establish measures to identify the operating status of components of the packaging, such as tagging valves and switches, to prevent inadvertent operation.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-180, filed 12/12/16, effective 1/12/17. Statutory Authority:

RCW 70.98.050. WSR 08-09-093, § 246-231-180, filed 4/18/08, effective 5/19/08.]

WAC 246-231-182 Nonconforming materials, parts, or components.

The licensee, certificate holder, and applicant for a certificate of compliance shall establish measures to control materials, parts, or components that do not conform to the licensee's requirements to prevent their inadvertent use or installation. These measures must include, as appropriate, procedures for identification, documentation, segregation, disposition, and notification to affected organizations. Nonconforming items must be reviewed and accepted, rejected, repaired, or reworked in accordance with documented procedures.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-182, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 08-09-093, § 246-231-182, filed 4/18/08, effective 5/19/08.]

WAC 246-231-184 Corrective action. The licensee, certificate holder, and applicant for a certificate of compliance shall establish measures to assure that conditions adverse to quality, such as deficiencies, deviations, defective material and equipment, and noncon-

formance, are promptly identified and corrected. In the case of a significant condition adverse to quality, the measures must assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken must be documented and reported to appropriate levels of management.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-184, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 08-09-093, § 246-231-184, filed 4/18/08, effective 5/19/08.]

WAC 246-231-186 Quality assurance records. The licensee, certificate holder, and applicant for a certificate of compliance shall maintain sufficient written records to describe the activities affecting quality. These records must include changes to the quality assurance program as required by 10 C.F.R. 71.106, the instructions, procedures, and drawings required by 10 C.F.R. 71.111 to prescribe quality assurance activities, and closely related specifications such as required qualifications of personnel, procedures, and equipment. The records must include the instructions or procedures that establish a records

retention program that is consistent with applicable regulations and designates factors such as duration, location, and assigned responsibility. The licensee, certificate holder, and applicant for a certificate of compliance shall retain these records for three years beyond the date when the licensee, certificate holder, and applicant for a certificate of compliance last engaged in the activity for which the quality assurance program was developed. If any portion of the quality assurance program, written procedures or instructions is superseded, the licensee, certificate holder, and applicant for a certificate of compliance shall retain the superseded material for three years after it is superseded.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-186, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-186, filed 4/7/14, effective 5/8/14; WSR 08-09-093, § 246-231-186, filed 4/18/08, effective 5/19/08.]

WAC 246-231-188 Audits. The licensee, certificate holder, and applicant for a certificate of compliance shall carry out a comprehensive system of planned and periodic audits to verify compliance with all aspects of the quality assurance program and to determine the ef-

fectiveness of the program. The audits must be performed in accordance with written procedures or checklists by appropriately trained personnel not having direct responsibilities in the areas being audited. Audited results must be documented and reviewed by management having responsibility in the area audited. Follow-up action, including re-audit of deficient areas, must be taken where indicated.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-188, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 08-09-093, § 246-231-188, filed 4/18/08, effective 5/19/08.]

WAC 246-231-200 Appendix A—Determination of A1 and A2. (1) Values of A1 and A2 for individual radionuclides, which are the basis for many activity limits elsewhere in these regulations, are given in this section, Table A-1. The curie (Ci) values specified are obtained by converting from the Terabecquerel (TBq) value. The Terabecquerel values are the regulatory standard. The curie values are for information only and are not intended to be the regulatory standard. Where values of A1 or A2 are unlimited, it is for radiation control purposes only. For nuclear criticality safety, some materials are subject to controls placed on fissile material.

(2)(a) For individual radionuclides whose identities are known, but which are not listed in this section, Table A-1, the A1 and A2 values contained in this section, Table A-3 may be used. Otherwise, the licensee shall obtain prior NRC approval of the A1 and A2 values for radionuclides not listed in this section, Table A-1, before shipping the material.

(b) For individual radionuclides whose identities are known, but which are not listed in this section, Table A-2, the exempt material activity concentration and exempt consignment activity values contained in this section, Table A-3 may be used. Otherwise, the licensee shall obtain prior NRC approval of the exempt material activity concentration and exempt consignment activity values for radionuclides not listed in this section, Table A-2, before shipping the material.

(c) The licensee shall submit requests for prior approval, described under (a) and (b) of this subsection, to NRC in accordance with 10 C.F.R. 71.1.

(3) In the calculations of A1 and A2 for a radionuclide not in this section, Table A-1, a single radioactive decay chain, in which radionuclides are present in their naturally occurring proportions, and in which no daughter radionuclide has a half-life either longer than ten days, or longer than that of the parent radionuclide, shall

be considered as a single radionuclide, and the activity to be taken into account, and the A1 or A2 value to be applied shall be those corresponding to the parent radionuclide of that chain. In the case of radioactive decay chains in which any daughter radionuclide has a half-life either longer than ten days, or greater than that of the parent radionuclide, the parent and those daughter radionuclides shall be considered as mixtures of different radionuclides.

(4) For mixtures of radionuclides whose identities and respective activities are known, the following conditions apply:

(a) For special form radioactive material, the maximum quantity transported in a Type A package is as follows:

$$\sum_i \frac{B(i)}{A_1(i)} \leq 1$$

Where B(i) is the activity of radionuclide i in special form, and A₁(i) is the A₁ value for radionuclide i.

(b) For normal form radioactive material, the maximum quantity transported in a Type A package:

$$\sum_i \frac{B(i)}{A_2(i)} \leq 1$$

Where B(i) is the activity of radionuclide i in normal form, and A₂(i) is the A₂ value for radionuclide i.

(c) If the package contains both special and normal form radioactive material, the activity that may be transported in a Type A package is as follows:

$$\sum_i \frac{B(i)}{A_1(i)} + \sum_j \frac{C(j)}{A_2(j)} \leq 1$$

Where B(i) is the activity of radionuclide i as special form radioactive material, A₁(i) is the A₁ value for radionuclide i, C(j) is the activity of radionuclide j as normal form radioactive material, and A₂(j) is the A₂ value for radionuclide j.

(d) Alternatively, the A₁ value for mixtures of special form material may be determined as follows:

$$A_1 \text{ for mixture} = \frac{1}{\sum_i \frac{f(i)}{A_1(i)}}$$

Where f(i) is the fraction of activity for radionuclide i in the mixture and A₁(i) is the appropriate A₁ value for radionuclide i.

(e) Alternatively, the A₂ value for mixtures of normal form material may be determined as follows:

$$A_2 \text{ for mixture} = \frac{1}{\sum_i \frac{f(i)}{A_2(i)}}$$

Where $f(i)$ is the fraction of activity for radionuclide i in the mixture and $A_2(i)$ is the appropriate A_2 value for radionuclide i .

(f) The exempt activity concentration for mixtures of nuclides may be determined as follows:

Exempt activity concentration for mixture

Where $f(i)$ is the fraction of activity concentration of radionuclide i in the mixture, and $[A](i)$ is the activity concentration for exempt material containing radionuclide i .

(g) The activity limit for an exempt consignment for mixtures of radionuclides may be determined as follows:

Exempt consignment activity limit for mixt

Where $f(i)$ is the fraction of activity of radionuclide i in the mixture and $A(i)$ is the activity limit for exempt consignments for radionuclide i .

(5)(a) When the identity of each radionuclide is known, but the individual activities of some of the radionuclides are not known, the

radionuclides may be grouped and the lowest A1 or A2 value, as appropriate, for the radionuclides in each group may be used in applying the formulas in subsection (4) of this section. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest A1 or A2 values for the alpha emitters and beta/gamma emitters.

(b) When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest [A] (activity concentration for exempt material) or A (activity limit for exempt consignment) value, as appropriate, for the radionuclides in each group may be used in applying the formulas in paragraph IV of this appendix. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest [A] or A values for the alpha emitters and beta/gamma emitters, respectively.

Table A-1.—A1 and A2 Values for Radionuclides

Symbol of radionuclide	Element and atomic number	A1 (TBq)	A1 (Ci) ^b	A2 (TBq)	A2 (Ci) ^b	Specific activity	
						(TBq/g)	(Ci/g)
Ac-225 (a)	Actinium (89)	8.0X10 ⁻¹	2.2X10 ¹	6.0X10 ⁻³	1.6X10 ⁻¹	2.1X10 ³	5.8X10 ¹
Ac-227 (a)		9.0X10 ⁻¹	2.4X10 ¹	9.0X10 ⁻⁵	2.4X10 ⁻³	2.7	7.2X10 ¹
Ac-228		6.0X10 ⁻¹	1.6X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	8.4X10 ¹	2.2X10 ⁶
Ag-105	Silver (47)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	1.1X10 ³	3.0X10 ¹
Ag-108m (a)		7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	9.7X10 ⁻¹	2.6X10 ¹
Ag-110m (a)		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.8X10 ²	4.7X10 ²
Ag-111		2.0	5.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	5.8X10 ³	1.6X10 ²
Al-26	Aluminum (13)	1.0X10 ⁻¹	2.7	1.0X10 ⁻¹	2.7	7.0X10 ⁻⁴	1.9X10 ⁻²
Am-241	Americium (95)	1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	1.3X10 ⁻¹	3.4
Am-242m (a)		1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	3.6X10 ⁻¹	1.0X10 ¹
Am-243 (a)		5.0	1.4X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	7.4X10 ⁻³	2.0X10 ⁻¹
Ar-37	Argon (18)	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	3.7X10 ³	9.9X10 ¹

Symbol of radionuclide	Element and atomic number	A1 (TBq)	A1 (Ci) ^b	A2 (TBq)	A2 (Ci) ^b	Specific activity	
						(TBq/g)	(Ci/g)
Ar-39		4.0X10 ¹	1.1X10 ³	2.0X10 ¹	5.4X10 ²	1.3	3.4X10 ¹
Ar-41		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.5X10 ⁶	4.2X10 ⁷
As-72	Arsenic (33)	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	6.2X10 ⁴	1.7X10 ⁶
As-73		4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	8.2X10 ²	2.2X10 ⁴
As-74		1.0	2.7X10 ¹	9.0X10 ⁻¹	2.4X10 ¹	3.7X10 ³	9.9X10 ⁴
As-76		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	5.8X10 ⁴	1.6X10 ⁶
As-77		2.0X10 ¹	5.4X10 ²	7.0X10 ⁻¹	1.9X10 ¹	3.9X10 ⁴	1.0X10 ⁶
At-211 (a)	Astatine (85)	2.0X10 ¹	5.4X10 ²	5.0X10 ⁻¹	1.4X10 ¹	7.6X10 ⁴	2.1X10 ⁶
Au-193	Gold (79)	7.0	1.9X10 ³	2.0	5.4X10 ¹	3.4X10 ⁴	9.2X10 ⁵
Au-194		1.0	2.7X10 ¹	1.0	2.7X10 ¹	1.5X10 ⁴	4.1X10 ⁵
Au-195		1.0X10 ¹	2.7X10 ²	6.0	1.6X10 ²	1.4X10 ²	3.7X10 ³
Au-198		1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	9.0X10 ³	2.4X10 ⁵
Au-199		1.0X10 ¹	2.7X10 ²	6.0X10 ⁻¹	1.6X10 ¹	7.7X10 ³	2.1X10 ⁵
Ba-131 (a)	Barium (56)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	3.1X10 ³	8.4X10 ⁴
Ba-133		3.0	8.1X10 ¹	3.0	8.1X10 ¹	9.4	2.6X10 ²
Ba-133m		2.0X10 ¹	5.4X10 ²	6.0X10 ⁻¹	1.6X10 ¹	2.2X10 ⁴	6.1X10 ⁵
Ba-140 (a)		5.0X10 ⁻¹	1.4X10 ¹	3.0X10 ⁻¹	8.1	2.7X10 ³	7.3X10 ⁴
Be-7	Beryllium (4)	2.0X10 ¹	5.4X10 ²	2.0X10 ¹	5.4X10 ²	1.3X10 ⁴	3.5X10 ⁵
Be-10		4.0X10 ¹	1.1X10 ³	6.0X10 ⁻¹	1.6X10 ¹	8.3X10 ⁻⁴	2.2X10 ⁻²
Bi-205	Bismuth (83)	7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	1.5X10 ³	4.2X10 ⁴
Bi-206		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	3.8X10 ³	1.0X10 ⁵
Bi-207		7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	1.9	5.2X10 ¹
Bi-210		1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	4.6X10 ³	1.2X10 ⁵
Bi-210m (a)		6.0X10 ⁻¹	1.6X10 ¹	2.0X10 ⁻²	5.4X10 ⁻¹	2.1X10 ⁻⁵	5.7X10 ⁻⁴
Bi-212 (a)		7.0X10 ⁻¹	1.9X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	5.4X10 ⁵	1.5X10 ⁷
Bk-247	Berkelium (97)	8.0	2.2X10 ²	8.0X10 ⁻⁴	2.2X10 ⁻²	3.8X10 ⁻²	1.0
Bk-249 (a)		4.0X10 ¹	1.1X10 ³	3.0X10 ⁻¹	8.1	6.1X10 ¹	1.6X10 ³
Br-76	Bromine (35)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	9.4X10 ⁴	2.5X10 ⁶
Br-77		3.0	8.1X10 ¹	3.0	8.1X10 ¹	2.6X10 ⁴	7.1X10 ⁵
Br-82		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁴	1.1X10 ⁶
C-11	Carbon (6)	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.1X10 ⁷	8.4X10 ⁸
C-14		4.0X10 ¹	1.1X10 ³	3.0	8.1X10 ¹	1.6X10 ⁻¹	4.5
Ca-41	Calcium (20)	Unlimited	Unlimited	Unlimited	Unlimited	3.1X10 ⁻³	8.5X10 ⁻²
Ca-45		4.0X10 ¹	1.1X10 ³	1.0	2.7X10 ¹	6.6X10 ²	1.8X10 ⁴
Ca-47 (a)		3.0	8.1X10 ¹	3.0X10 ⁻¹	8.1	2.3X10 ⁴	6.1X10 ⁵
Cd-109	Cadmium (48)	3.0X10 ¹	8.1X10 ²	2.0	5.4X10 ¹	9.6X10 ¹	2.6X10 ³
Cd-113m		4.0X10 ¹	1.1X10 ³	5.0X10 ⁻¹	1.4X10 ¹	8.3	2.2X10 ²
Cd-115 (a)		3.0	8.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.9X10 ⁴	5.1X10 ⁵
Cd-115m		5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	9.4X10 ²	2.5X10 ⁴
Ce-139	Cerium (58)	7.0	1.9X10 ²	2.0	5.4X10 ¹	2.5X10 ²	6.8X10 ³
Ce-141		2.0X10 ¹	5.4X10 ²	6.0X10 ⁻¹	1.6X10 ¹	1.1X10 ³	2.8X10 ⁴
Ce-143		9.0X10 ⁻¹	2.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.5X10 ⁴	6.6X10 ⁵
Ce-144 (a)		2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	1.2X10 ²	3.2X10 ³
Cf-248	Californium (98)	4.0X10 ¹	1.1X10 ³	6.0X10 ⁻³	1.6X10 ⁻¹	5.8X10 ¹	1.6X10 ³
Cf-249		3.0	8.1X10 ¹	8.0X10 ⁻⁴	2.2X10 ⁻²	1.5X10 ⁻¹	4.1
Cf-250		2.0X10 ¹	5.4X10 ²	2.0X10 ⁻³	5.4X10 ⁻²	4.0	1.1X10 ²
Cf-251		7.0	1.9X10 ²	7.0X10 ⁻⁴	1.9X10 ⁻²	5.9X10 ⁻²	1.6
Cf-252		1.0X10 ⁻¹	2.7	3.0X10 ⁻³	8.1X10 ⁻²	2.0X10 ¹	5.4X10 ²
Cf-253 (a)		4.0X10 ¹	1.1X10 ³	4.0X10 ⁻²	1.1	1.1X10 ³	2.9X10 ⁴
Cf-254		1.0X10 ⁻³	2.7X10 ⁻²	1.0X10 ⁻³	2.7X10 ⁻²	3.1X10 ²	8.5X10 ³
Cl-36	Chlorine (17)	1.0X10 ¹	2.7X10 ²	6.0X10 ⁻¹	1.6X10 ¹	1.2X10 ⁻³	3.3X10 ⁻²
Cl-38		2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	4.9X10 ⁶	1.3X10 ⁸
Cm-240	Curium (96)	4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	7.5X10 ²	2.0X10 ⁴
Cm-241		2.0	5.4X10 ¹	1.0	2.7X10 ¹	6.1X10 ²	1.7X10 ⁴
Cm-242		4.0X10 ¹	1.1X10 ³	1.0X10 ⁻²	2.7X10 ⁻¹	1.2X10 ²	3.3X10 ³
Cm-243		9.0	2.4X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	1.9X10 ⁻³	5.2X10 ¹

Symbol of radionuclide	Element and atomic number	A1 (TBq)	A1 (Ci) ^b	A2 (TBq)	A2 (Ci) ^b	Specific activity	
						(TBq/g)	(Ci/g)
Cm-244		2.0X10 ¹	5.4X10 ²	2.0X10 ⁻³	5.4X10 ⁻²	3.0	8.1X10 ¹
Cm-245		9.0	2.4X10 ²	9.0X10 ⁻⁴	2.4X10 ⁻²	6.4X10 ⁻³	1.7X10 ¹
Cm-246		9.0	2.4X10 ²	9.0X10 ⁻⁴	2.4X10 ⁻²	1.1X10 ⁻²	3.1X10 ¹
Cm-247 (a)		3.0	8.1X10 ¹	1.0X10 ⁻³	2.7X10 ⁻²	3.4X10 ⁻⁶	9.3X10 ⁻⁵
Cm-248		2.0X10 ⁻²	5.4X10 ⁻¹	3.0X10 ⁻⁴	8.1X10 ⁻³	1.6X10 ⁻⁴	4.2X10 ⁻³
Co-55	Cobalt (27)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	1.1X10 ⁵	3.1X10 ⁶
Co-56		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.1X10 ³	3.0X10 ⁴
Co-57		1.0X10 ¹	2.7X10 ²	1.0X10 ¹	2.7X10 ²	3.1X10 ²	8.4X10 ³
Co-58		1.0	2.7X10 ¹	1.0	2.7X10 ¹	1.2X10 ³	3.2X10 ⁴
Co-58m		4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	2.2X10 ⁵	5.9X10 ⁶
Co-60		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	4.2X10 ¹	1.1X10 ³
Cr-51	Chromium (24)	3.0X10 ¹	8.1X10 ²	3.0X10 ¹	8.1X10 ²	3.4X10 ³	9.2X10 ⁴
Cs-129	Cesium (55)	4.0	1.1X10 ²	4.0	1.1X10 ²	2.8X10 ⁴	7.6X10 ⁵
Cs-131		3.0X10 ¹	8.1X10 ²	3.0X10 ¹	8.1X10 ²	3.8X10 ³	1.0X10 ⁵
Cs-132		1.0	2.7X10 ¹	1.0	2.7X10 ¹	5.7X10 ³	1.5X10 ⁵
Cs-134		7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	4.8X10 ¹	1.3X10 ³
Cs-134m		4.0X10 ¹	1.1X10 ³	6.0X10 ⁻¹	1.6X10 ¹	3.0X10 ⁵	8.0X10 ⁶
Cs-135		4.0X10 ¹	1.1X10 ³	1.0	2.7X10 ¹	4.3X10 ⁻⁵	1.2X10 ⁻³
Cs-136		5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	2.7X10 ³	7.3X10 ⁴
Cs-137 (a)		2.0	5.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.2	8.7X10 ¹
Cu-64	Copper (29)	6.0	1.6X10 ²	1.0	2.7X10 ¹	1.4X10 ⁵	3.9X10 ⁶
Cu-67		1.0X10 ¹	2.7X10 ²	7.0X10 ⁻¹	1.9X10 ¹	2.8X10 ⁴	7.6X10 ⁵
Dy-159	Dysprosium (66)	2.0X10 ¹	5.4X10 ²	2.0X10 ¹	5.4X10 ²	2.1X10 ²	5.7X10 ³
Dy-165		9.0X10 ⁻¹	2.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.0X10 ⁵	8.2X10 ⁶
Dy-166 (a)		9.0X10 ⁻¹	2.4X10 ¹	3.0X10 ⁻¹	8.1	8.6X10 ³	2.3X10 ⁵
Er-169	Erbium (68)	4.0X10 ¹	1.1X10 ³	1.0	2.7X10 ¹	3.1X10 ³	8.3X10 ⁴
Er-171		8.0X10 ⁻¹	2.2X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	9.0X10 ⁴	2.4X10 ⁶
Eu-147	Europium (63)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	1.4X10 ³	3.7X10 ⁴
Eu-148		5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	6.0X10 ²	1.6X10 ⁴
Eu-149		2.0X10 ¹	5.4X10 ²	2.0X10 ¹	5.4X10 ²	3.5X10 ²	9.4X10 ³
Eu-150 (short lived)		2.0	5.4X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	6.1X10 ⁴	1.6X10 ⁶
Eu-150 (long lived)		7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	6.1X10 ⁴	1.6X10 ⁶
Eu-152		1.0	2.7X10 ¹	1.0	2.7X10 ¹	6.5	1.8X10 ²
Eu-152m		8.0X10 ⁻¹	2.2X10 ¹	8.0X10 ⁻¹	2.2X10 ¹	8.2X10 ⁴	2.2X10 ⁶
Eu-154		9.0X10 ⁻¹	2.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	9.8	2.6X10 ²
Eu-155		2.0X10 ¹	5.4X10 ²	3.0	8.1X10 ¹	1.8X10 ¹	4.9X10 ²
Eu-156		7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	2.0X10 ³	5.5X10 ⁴
F-18	Fluorine (9)	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.5X10 ⁶	9.5X10 ⁷
Fe-52 (a)	Iron (26)	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	2.7X10 ⁵	7.3X10 ⁶
Fe-55		4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	8.8X10 ¹	2.4X10 ³
Fe-59		9.0X10 ⁻¹	2.4X10 ¹	9.0X10 ⁻¹	2.4X10 ¹	1.8X10 ³	5.0X10 ⁴
Fe-60 (a)		4.0X10 ¹	1.1X10 ³	2.0X10 ⁻¹	5.4	7.4X10 ⁻⁴	2.0X10 ⁻²
Ga-67	Gallium (31)	7.0	1.9X10 ²	3.0	8.1X10 ¹	2.2X10 ⁴	6.0X10 ⁵
Ga-68		5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	1.5X10 ⁶	4.1X10 ⁷
Ga-72		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.1X10 ⁵	3.1X10 ⁶
Gd-146 (a)	Gadolinium (64)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	6.9X10 ²	1.9X10 ⁴
Gd-148		2.0X10 ¹	5.4X10 ²	2.0X10 ⁻³	5.4X10 ⁻²	1.2	3.2X10 ¹
Gd-153		1.0X10 ¹	2.7X10 ²	9.0	2.4X10 ²	1.3X10 ²	3.5X10 ³
Gd-159		3.0	8.1X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.9X10 ⁴	1.1X10 ⁶
Ge-68 (a)	Germanium (32)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	2.6X10 ²	7.1X10 ³
Ge-71		4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	5.8X10 ³	1.6X10 ⁵
Ge-77		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.3X10 ⁵	3.6X10 ⁶
Hf-172 (a)	Hafnium (72)	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	4.1X10 ¹	1.1X10 ³
Hf-175		3.0	8.1X10 ¹	3.0	8.1X10 ¹	3.9X10 ²	1.1X10 ⁴
Hf-181		2.0	5.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	6.3X10 ²	1.7X10 ⁴
Hf-182		Unlimited	Unlimited	Unlimited	Unlimited	8.1X10 ⁻⁶	2.2X10 ⁻⁴

Symbol of radionuclide	Element and atomic number	A1 (TBq)	A1 (Ci) ^b	A2 (TBq)	A2 (Ci) ^b	Specific activity	
						(TBq/g)	(Ci/g)
Hg-194 (a)	Mercury (80)	1.0	2.7X10 ¹	1.0	2.7X10 ¹	1.3X10 ⁻¹	3.5
Hg-195m (a)		3.0	8.1X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	1.5X10 ⁻¹	4.0X10 ⁰
Hg-197		2.0X10 ¹	5.4X10 ²	1.0X10 ¹	2.7X10 ²	9.2X10 ³	2.5X10 ⁰
Hg-197m		1.0X10 ¹	2.7X10 ²	4.0X10 ⁻¹	1.1X10 ¹	2.5X10 ⁻¹	6.7X10 ⁰
Hg-203		5.0	1.4X10 ²	1.0	2.7X10 ¹	5.1X10 ²	1.4X10 ¹
Ho-166	Holmium (67)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	2.6X10 ⁻¹	7.0X10 ⁰
Ho-166m		6.0X10 ⁻¹	1.6X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	6.6X10 ⁻²	1.8
I-123	Iodine (53)	6.0	1.6X10 ²	3.0	8.1X10 ¹	7.1X10 ⁻¹	1.9X10 ⁰
I-124		1.0	2.7X10 ¹	1.0	2.7X10 ¹	9.3X10 ³	2.5X10 ⁰
I-125		2.0X10 ¹	5.4X10 ²	3.0	8.1X10 ¹	6.4X10 ²	1.7X10 ⁻¹
I-126		2.0	5.4X10 ¹	1.0	2.7X10 ¹	2.9X10 ³	8.0X10 ⁻¹
I-129		Unlimited	Unlimited	Unlimited	Unlimited	6.5X10 ⁻⁶	1.8X10 ⁻¹
I-131		3.0	8.1X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	4.6X10 ³	1.2X10 ⁰
I-132		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	3.8X10 ⁵	1.0X10 ¹
I-133		7.0X10 ⁻¹	1.9X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	4.2X10 ⁻¹	1.1X10 ⁰
I-134		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	9.9X10 ⁵	2.7X10 ¹
I-135 (a)		6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.3X10 ⁵	3.5X10 ⁰
In-111	Indium (49)	3.0	8.1X10 ¹	3.0	8.1X10 ¹	1.5X10 ⁻¹	4.2X10 ⁰
In-113m		4.0	1.1X10 ²	2.0	5.4X10 ¹	6.2X10 ⁵	1.7X10 ¹
In-114m (a)		1.0X10 ¹	2.7X10 ²	5.0X10 ⁻¹	1.4X10 ¹	8.6X10 ²	2.3X10 ⁻¹
In-115m		7.0	1.9X10 ²	1.0	2.7X10 ¹	2.2X10 ⁵	6.1X10 ⁰
Ir-189 (a)	Iridium (77)	1.0X10 ¹	2.7X10 ²	1.0X10 ¹	2.7X10 ²	1.9X10 ³	5.2X10 ⁻¹
Ir-190		7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	2.3X10 ³	6.2X10 ⁻¹
Ir-192		1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.4X10 ²	9.2X10 ³
Ir-194		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	3.1X10 ⁻¹	8.4X10 ⁰
K-40	Potassium (19)	9.0X10 ⁻¹	2.4X10 ¹	9.0X10 ⁻¹	2.4X10 ¹	2.4X10 ⁻⁷	6.4X10 ⁻⁶
K-42		2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	2.2X10 ⁵	6.0X10 ⁰
K-43		7.0X10 ⁻¹	1.9X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.2X10 ⁵	3.3X10 ⁰
Kr-79	Krypton (36)	4.0	1.1X10 ²	2.0	5.4X10 ¹	4.2X10 ⁻¹	1.1X10 ⁰
Kr-81		4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	7.8X10 ⁻⁴	2.1X10 ⁻³
Kr-85		1.0X10 ¹	2.7X10 ²	1.0X10 ¹	2.7X10 ²	1.5X10 ⁻¹	3.9X10 ⁰
Kr-85m		8.0	2.2X10 ²	3.0	8.1X10 ¹	3.0X10 ⁵	8.2X10 ⁰
Kr-87		2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	1.0X10 ⁶	2.8X10 ¹
La-137	Lanthanum (57)	3.0X10 ¹	8.1X10 ²	6.0	1.6X10 ²	1.6X10 ⁻³	4.4X10 ⁻³
La-140		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	2.1X10 ⁻¹	5.6X10 ⁰
Lu-172	Lutetium (71)	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	4.2X10 ³	1.1X10 ⁰
Lu-173		8.0	2.2X10 ²	8.0	2.2X10 ²	5.6X10 ¹	1.5X10 ³
Lu-174		9.0	2.4X10 ²	9.0	2.4X10 ²	2.3X10 ¹	6.2X10 ²
Lu-174m		2.0X10 ¹	5.4X10 ²	1.0X10 ¹	2.7X10 ²	2.0X10 ²	5.3X10 ³
Lu-177		3.0X10 ¹	8.1X10 ²	7.0X10 ⁻¹	1.9X10 ¹	4.1X10 ³	1.1X10 ⁰
Mg-28 (a)	Magnesium (12)	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	2.0X10 ⁵	5.4X10 ⁰
Mn-52	Manganese (25)	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.6X10 ⁻¹	4.4X10 ⁰
Mn-53		Unlimited	Unlimited	Unlimited	Unlimited	6.8X10 ⁻⁵	1.8X10 ⁻³
Mn-54		1.0	2.7X10 ¹	1.0	2.7X10 ¹	2.9X10 ²	7.7X10 ³
Mn-56		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	8.0X10 ⁵	2.2X10 ¹
Mo-93	Molybdenum (42)	4.0X10 ¹	1.1X10 ³	2.0X10 ¹	5.4X10 ²	4.1X10 ⁻²	1.1
Mo-99 (a) (h)		1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.8X10 ⁻¹	4.8X10 ⁰
N-13	Nitrogen (7)	9.0X10 ⁻¹	2.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	5.4X10 ⁷	1.5X10 ⁰
Na-22	Sodium (11)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	2.3X10 ²	6.3X10 ³
Na-24		2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	3.2X10 ⁵	8.7X10 ⁰
Nb-93m	Niobium (41)	4.0X10 ¹	1.1X10 ³	3.0X10 ¹	8.1X10 ²	8.8	2.4X10 ²
Nb-94		7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	6.9X10 ⁻³	1.9X10 ⁻¹
Nb-95		1.0	2.7X10 ¹	1.0	2.7X10 ¹	1.5X10 ³	3.9X10 ⁻¹
Nb-97		9.0X10 ⁻¹	2.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	9.9X10 ⁵	2.7X10 ¹
Nd-147	Neodymium (60)	6.0	1.6X10 ²	6.0X10 ⁻¹	1.6X10 ¹	3.0X10 ³	8.1X10 ⁻¹

Symbol of radionuclide	Element and atomic number	A1 (TBq)	A1 (Ci) ^b	A2 (TBq)	A2 (Ci) ^b	Specific activity	
						(TBq/g)	(Ci/g)
Nd-149		6.0X10 ⁻¹	1.6X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	4.5X10 ⁵	1.2X10 ⁷
Ni-59	Nickel (28)	Unlimited	Unlimited	Unlimited	Unlimited	3.0X10 ⁻³	8.0X10 ⁻²
Ni-63		4.0X10 ¹	1.1X10 ³	3.0X10 ¹	8.1X10 ²	2.1	5.7X10 ¹
Ni-65		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	7.1X10 ⁵	1.9X10 ⁷
Np-235	Neptunium (93)	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	5.2X10 ¹	1.4X10 ³
Np-236 (short-lived)		2.0X10 ¹	5.4X10 ²	2.0	5.4X10 ¹	4.7X10 ⁻⁴	1.3X10 ⁻²
Np-236 (long-lived)		9.0	2.4X10 ²	2.0X10 ⁻²	5.4X10 ⁻¹	4.7X10 ⁻⁴	1.3X10 ⁻²
Np-237		2.0X10 ¹	5.4X10 ²	2.0X10 ⁻³	5.4X10 ⁻²	2.6X10 ⁻⁵	7.1X10 ⁻⁴
Np-239		7.0	1.9X10 ²	4.0X10 ⁻¹	1.1X10 ¹	8.6X10 ³	2.3X10 ⁵
Os-185	Osmium (76)	1.0	2.7X10 ¹	1.0	2.7X10 ¹	2.8X10 ²	7.5X10 ³
Os-191		1.0X10 ¹	2.7X10 ²	2.0	5.4X10 ¹	1.6X10 ³	4.4X10 ⁴
Os-191m		4.0X10 ¹	1.1X10 ³	3.0X10 ¹	8.1X10 ²	4.6X10 ⁴	1.3X10 ⁶
Os-193		2.0	5.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	b2.0X10 ⁴	5.3X10 ⁵
Os-194 (a)		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.1X10 ¹	3.1X10 ²
P-32	Phosphorus (15)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	1.1X10 ⁴	2.9X10 ⁵
P-33		4.0X10 ¹	1.1X10 ³	1.0	2.7X10 ¹	5.8X10 ³	1.6X10 ⁵
Pa-230 (a)	Protactinium (91)	2.0	5.4X10 ¹	7.0X10 ⁻²	1.9	1.2X10 ³	3.3X10 ⁴
Pa-231		4.0	1.1X10 ²	4.0X10 ⁻¹	1.1X10 ⁻²	1.7X10 ⁻³	4.7X10 ⁻²
Pa-233		5.0	1.4X10 ²	7.0X10 ⁻¹	1.9X10 ¹	7.7X10 ²	2.1X10 ⁴
Pb-201	Lead (82)	1.0	2.7X10 ¹	1.0	2.7X10 ¹	6.2X10 ⁴	1.7X10 ⁶
Pb-202		4.0X10 ¹	1.1X10 ³	2.0X10 ¹	5.4X10 ²	1.2X10 ⁻⁴	3.4X10 ⁻³
Pb-203		4.0	1.1X10 ²	3.0	8.1X10 ¹	1.1X10 ⁴	3.0X10 ⁵
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	4.5X10 ⁻⁶	1.2X10 ⁻⁴
Pb-210 (a)		1.0	2.7X10 ¹	5.0X10 ⁻²	1.4	2.8	7.6X10 ¹
Pb-212 (a)		7.0X10 ⁻¹	1.9X10 ¹	2.0X10 ⁻¹	5.4	5.1X10 ⁴	1.4X10 ⁶
Pd-103 (a)	Palladium (46)	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	2.8X10 ³	7.5X10 ⁴
Pd-107		Unlimited	Unlimited	Unlimited	Unlimited	1.9X10 ⁻⁵	5.1X10 ⁻⁴
Pd-109		2.0	5.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	7.9X10 ⁴	2.1X10 ⁶
Pm-143	Promethium (61)	3.0	8.1X10 ¹	3.0	8.1X10 ¹	1.3X10 ²	3.4X10 ³
Pm-144		7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	9.2X10 ¹	2.5X10 ³
Pm-145		3.0X10 ¹	8.1X10 ²	1.0X10 ¹	2.7X10 ²	5.2	1.4X10 ²
Pm-147		4.0X10 ¹	1.1X10 ³	2.0	5.4X10 ¹	3.4X10 ¹	9.3X10 ²
Pm-148m (a)		8.0X10 ⁻¹	2.2X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	7.9X10 ²	2.1X10 ⁴
Pm-149		2.0	5.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.5X10 ⁴	4.0X10 ⁵
Pm-151		2.0	5.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.7X10 ⁴	7.3X10 ⁵
Po-210	Polonium (84)	4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	1.7X10 ²	4.5X10 ³
Pr-142	Praseodymium (59)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	4.3X10 ⁴	1.2X10 ⁶
Pr-143		3.0	8.1X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.5X10 ³	6.7X10 ⁴
Pt-188 (a)	Platinum (78)	1.0	2.7X10 ¹	8.0X10 ⁻¹	2.2X10 ¹	2.5X10 ³	6.8X10 ⁴
Pt-191		4.0	1.1X10 ²	3.0	8.1X10 ¹	8.7X10 ³	2.4X10 ⁵
Pt-193		4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	1.4	3.7X10 ¹
Pt-193m		4.0X10 ¹	1.1X10 ³	5.0X10 ⁻¹	1.4X10 ¹	5.8X10 ³	1.6X10 ⁵
Pt-195m		1.0X10 ¹	2.7X10 ²	5.0X10 ⁻¹	1.4X10 ¹	6.2X10 ³	1.7X10 ⁵
Pt-197		2.0X10 ¹	5.4X10 ²	6.0X10 ⁻¹	1.6X10 ¹	3.2X10 ⁴	8.7X10 ⁵
Pt-197m		1.0X10 ¹	2.7X10 ²	6.0X10 ⁻¹	1.6X10 ¹	3.7X10 ⁵	1.0X10 ⁷
Pu-236	Plutonium (94)	3.0X10 ¹	8.1X10 ²	3.0X10 ⁻³	8.1X10 ⁻²	2.0X10 ¹	5.3X10 ²
Pu-237		2.0X10 ¹	5.4X10 ²	2.0X10 ¹	5.4X10 ²	4.5X10 ²	1.2X10 ⁴
Pu-238		1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	6.3X10 ⁻¹	1.7X10 ¹
Pu-239		1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	2.3X10 ⁻³	6.2X10 ⁻²
Pu-240		1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	8.4X10 ⁻³	2.3X10 ⁻¹
Pu-241 (a)		4.0X10 ¹	1.1X10 ³	6.0X10 ⁻²	1.6	3.8	1.0X10 ²
Pu-242		1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	1.5X10 ⁻⁴	3.9X10 ⁻³
Pu-244 (a)		4.0X10 ⁻¹	1.1X10 ¹	1.0X10 ⁻³	2.7X10 ⁻²	6.7X10 ⁻⁷	1.8X10 ⁻⁵
Ra-223 (a)	Radium (88)	4.0X10 ⁻¹	1.1X10 ¹	7.0X10 ⁻³	1.9X10 ⁻¹	1.9X10 ³	5.1X10 ⁴
Ra-224 (a)		4.0X10 ⁻¹	1.1X10 ¹	2.0X10 ⁻²	5.4X10 ⁻¹	5.9X10 ³	1.6X10 ⁵

Symbol of radionuclide	Element and atomic number	A1 (TBq)	A1 (Ci) ^b	A2 (TBq)	A2 (Ci) ^b	Specific activity	
						(TBq/g)	(Ci/g)
Ra-225 (a)		2.0X10 ⁻¹	5.4	4.0X10 ⁻³	1.1X10 ⁻¹	1.5X10 ³	3.9X10 ⁴
Ra-226 (a)		2.0X10 ⁻¹	5.4	3.0X10 ⁻³	8.1X10 ⁻²	3.7X10 ²	1.0
Ra-228 (a)		6.0X10 ⁻¹	1.6X10 ¹	2.0X10 ⁻²	5.4X10 ⁻¹	1.0X10 ¹	2.7X10 ²
Rb-81	Rubidium (37)	2.0	5.4X10 ¹	8.0X10 ⁻¹	2.2X10 ¹	3.1X10 ⁵	8.4X10 ⁶
Rb-83 (a)		2.0	5.4X10 ¹	2.0	5.4X10 ¹	6.8X10 ²	1.8X10 ⁴
Rb-84		1.0	2.7X10 ¹	1.0	2.7X10 ¹	1.8X10 ³	4.7X10 ⁴
Rb-86		5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	3.0X10 ³	8.1X10 ⁴
Rb-87		Unlimited	Unlimited	Unlimited	Unlimited	3.2X10 ⁹	8.6X10 ⁸
Rb (nat)		Unlimited	Unlimited	Unlimited	Unlimited	6.7X10 ⁶	1.8X10 ⁸
Re-184	Rhenium (75)	1.0	2.7X10 ¹	1.0	2.7X10 ¹	6.9X10 ²	1.9X10 ⁴
Re-184m		3.0	8.1X10 ¹	1.0	2.7X10 ¹	1.6X10 ²	4.3X10 ³
Re-186		2.0	5.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	6.9X10 ³	1.9X10 ⁵
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	1.4X10 ⁹	3.8X10 ⁸
Re-188		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	3.6X10 ⁴	9.8X10 ⁵
Re-189 (a)		3.0	8.1X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.5X10 ⁴	6.8X10 ⁵
Re (nat)		Unlimited	Unlimited	Unlimited	Unlimited	0.0	2.4X10 ⁻⁸
Rh-99	Rhodium (45)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	3.0X10 ³	8.2X10 ⁴
Rh-101		4.0	1.1X10 ²	3.0	8.1X10 ¹	4.1X10 ¹	1.1X10 ³
Rh-102		5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	4.5X10 ¹	1.2X10 ³
Rh-102m		2.0	5.4X10 ¹	2.0	5.4X10 ¹	2.3X10 ²	6.2X10 ³
Rh-103m		4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	1.2X10 ⁶	3.3X10 ⁷
Rh-105		1.0X10 ¹	2.7X10 ²	8.0X10 ⁻¹	2.2X10 ¹	3.1X10 ⁴	8.4X10 ⁵
Rn-222 (a)	Radon (86)	3.0X10 ⁻¹	8.1	4.0X10 ⁻³	1.1X10 ⁻¹	5.7X10 ³	1.5X10 ⁵
Ru-97	Ruthenium (44)	5.0	1.4X10 ²	5.0	1.4X10 ²	1.7X10 ⁴	4.6X10 ⁵
Ru-103 (a)		2.0	5.4X10 ¹	2.0	5.4X10 ¹	1.2X10 ³	3.2X10 ⁴
Ru-105		1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.5X10 ⁵	6.7X10 ⁶
Ru-106 (a)		2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	1.2X10 ²	3.3X10 ³
S-35	Sulphur (16)	4.0X10 ¹	1.1X10 ³	3.0	8.1X10 ¹	1.6X10 ³	4.3X10 ⁴
Sb-122	Antimony (51)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.5X10 ⁴	4.0X10 ⁵
Sb-124		6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	6.5X10 ²	1.7X10 ⁴
Sb-125		2.0	5.4X10 ¹	1.0	2.7X10 ¹	3.9X10 ¹	1.0X10 ³
Sb-126		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	3.1X10 ³	8.4X10 ⁴
Sc-44	Scandium (21)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	6.7X10 ⁵	1.8X10 ⁷
Sc-46		5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	1.3X10 ³	3.4X10 ⁴
Sc-47		1.0X10 ¹	2.7X10 ²	7.0X10 ⁻¹	1.9X10 ¹	3.1X10 ⁴	8.3X10 ⁵
Sc-48		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	5.5X10 ⁴	1.5X10 ⁶
Se-75	Selenium (34)	3.0	8.1X10 ¹	3.0	8.1X10 ¹	5.4X10 ²	1.5X10 ⁴
Se-79		4.0X10 ¹	1.1X10 ³	2.0	5.4X10 ¹	2.6X10 ⁻³	7.0X10 ⁻²
Si-31	Silicon (14)	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.4X10 ⁶	3.9X10 ⁷
Si-32		4.0X10 ¹	1.1X10 ³	5.0X10 ⁻¹	1.4X10 ¹	3.9	1.1X10 ²
Sm-145	Samarium (62)	1.0X10 ¹	2.7X10 ²	1.0X10 ¹	2.7X10 ²	9.8X10 ¹	2.6X10 ³
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	8.5X10 ⁻¹	2.3X10 ⁻⁸
Sm-151		4.0X10 ¹	1.1X10 ³	1.0X10 ¹	2.7X10 ²	9.7X10 ⁻¹	2.6X10 ¹
Sm-153		9.0	2.4X10 ²	6.0X10 ⁻¹	1.6X10 ¹	1.6X10 ⁴	4.4X10 ⁵
Sn-113 (a)	Tin (50)	4.0	1.1X10 ²	2.0	5.4X10 ¹	3.7X10 ²	1.0X10 ⁴
Sn-117m		7.0	1.9X10 ²	4.0X10 ⁻¹	1.1X10 ¹	3.0X10 ³	8.2X10 ⁴
Sn-119m		4.0X10 ¹	1.1X10 ³	3.0X10 ¹	8.1X10 ²	1.4X10 ²	3.7X10 ³
Sn-121m (a)		4.0X10 ¹	1.1X10 ³	9.0X10 ⁻¹	2.4X10 ¹	2.0	5.4X10 ¹
Sn-123		8.0X10 ⁻¹	2.2X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.0X10 ²	8.2X10 ³
Sn-125		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ³	1.1X10 ⁵
Sn-126 (a)		6.0X10 ⁻¹	1.6X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.0X10 ⁻³	2.8X10 ⁻²
Sr-82 (a)	Strontium (38)	2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	2.3X10 ³	6.2X10 ⁴
Sr-85		2.0	5.4X10 ¹	2.0	5.4X10 ¹	8.8X10 ²	2.4X10 ⁴
Sr-85m		5.0	1.4X10 ²	5.0	1.4X10 ²	1.2X10 ⁶	3.3X10 ⁷
Sr-87m		3.0	8.1X10 ¹	3.0	8.1X10 ¹	4.8X10 ⁵	1.3X10 ⁷
Sr-89		6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.1X10 ³	2.9X10 ⁴

Symbol of radionuclide	Element and atomic number	A1 (TBq)	A1 (Ci) ^b	A2 (TBq)	A2 (Ci) ^b	Specific activity	
						(TBq/g)	(Ci/g)
Sr-90 (a)		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	5.1	1.4X10 ²
Sr-91 (a)		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.3X10 ⁵	3.6X10 ⁶
Sr-92 (a)		1.0	2.7X10 ¹	3.0X10 ⁻¹	8.1	4.7X10 ⁵	1.3X10 ⁷
T(H-3)	Tritium (1)	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	3.6X10 ²	9.7X10 ³
Ta-178 (long-lived)	Tantalum (73)	1.0	2.7X10 ¹	8.0X10 ⁻¹	2.2X10 ¹	4.2X10 ⁶	1.1X10 ⁸
Ta-179		3.0X10 ¹	8.1X10 ²	3.0X10 ¹	8.1X10 ²	4.1X10 ¹	1.1X10 ³
Ta-182		9.0X10 ⁻¹	2.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	2.3X10 ²	6.2X10 ³
Tb-157	Terbium (65)	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	5.6X10 ⁻¹	1.5X10 ¹
Tb-158		1.0	2.7X10 ¹	1.0	2.7X10 ¹	5.6X10 ⁻¹	1.5X10 ¹
Tb-160		1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	4.2X10 ²	1.1X10 ⁴
Tc-95m (a)	Technetium (43)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	8.3X10 ²	2.2X10 ⁴
Tc-96		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.2X10 ⁴	3.2X10 ⁵
Tc-96m (a)		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.4X10 ⁶	3.8X10 ⁷
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	5.2X10 ⁻⁵	1.4X10 ⁻³
Tc-97m		4.0X10 ¹	1.1X10 ³	1.0	2.7X10 ¹	5.6X10 ²	1.5X10 ⁴
Tc-98		8.0X10 ⁻¹	2.2X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	3.2X10 ⁻⁵	8.7X10 ⁻⁴
Tc-99		4.0X10 ¹	1.1X10 ³	9.0X10 ⁻¹	2.4X10 ¹	6.3X10 ⁻⁴	1.7X10 ⁻²
Tc-99m		1.0X10 ¹	2.7X10 ²	4.0	1.1X10 ²	1.9X10 ⁵	5.3X10 ⁶
Te-121	Tellurium (52)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	2.4X10 ³	6.4X10 ⁴
Te-121m		5.0	1.4X10 ²	3.0	8.1X10 ¹	2.6X10 ²	7.0X10 ³
Te-123m		8.0	2.2X10 ²	1.0	2.7X10 ¹	3.3X10 ²	8.9X10 ³
Te-125m		2.0X10 ¹	5.4X10 ²	9.0X10 ⁻¹	2.4X10 ¹	6.7X10 ²	1.8X10 ⁴
Te-127		2.0X10 ¹	5.4X10 ²	7.0X10 ⁻¹	1.9X10 ¹	9.8X10 ⁴	2.6X10 ⁶
Te-127m (a)		2.0X10 ¹	5.4X10 ²	5.0X10 ⁻¹	1.4X10 ¹	3.5X10 ²	9.4X10 ³
Te-129		7.0X10 ⁻¹	1.9X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	7.7X10 ⁵	2.1X10 ⁷
Te-129m (a)		8.0X10 ⁻¹	2.2X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.1X10 ³	3.0X10 ⁴
Te-131m (a)		7.0X10 ⁻¹	1.9X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	3.0X10 ⁴	8.0X10 ⁵
Te-132 (a)		5.0X10 ⁻¹	1.4X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.1X10 ⁴	3.0X10 ⁵
Th-227	Thorium (90)	1.0X10 ¹	2.7X10 ²	5.0X10 ⁻³	1.4X10 ⁻¹	1.1X10 ³	3.1X10 ⁴
Th-228 (a)		5.0X10 ⁻¹	1.4X10 ¹	1.0X10 ⁻³	2.7X10 ⁻²	3.0X10 ¹	8.2X10 ²
Th-229		5.0	1.4X10 ²	5.0X10 ⁻⁴	1.4X10 ⁻²	7.9X10 ⁻³	2.1X10 ⁻¹
Th-230		1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	7.6X10 ⁻⁴	2.1X10 ⁻²
Th-231		4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	2.0X10 ¹	5.3X10 ²
Th-232		Unlimited	Unlimited	Unlimited	Unlimited	4.0X10 ⁻⁹	1.1X10 ⁻⁷
Th-234 (a)		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	8.6X10 ²	2.3X10 ⁴
Th(nat)		Unlimited	Unlimited	Unlimited	Unlimited	8.1X10 ⁻⁹	2.2X10 ⁻⁷
Ti-44 (a)	Titanium (22)	5.0X10 ⁻¹	1.4X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	6.4	1.7X10 ²
Tl-200	Thallium (81)	9.0X10 ⁻¹	2.4X10 ¹	9.0X10 ⁻¹	2.4X10 ¹	2.2X10 ⁴	6.0X10 ⁵
Tl-201		1.0X10 ¹	2.7X10 ²	4.0	1.1X10 ²	7.9X10 ³	2.1X10 ⁵
Tl-202		2.0	5.4X10 ¹	2.0	5.4X10 ¹	2.0X10 ³	5.3X10 ⁴
Tl-204		1.0X10 ¹	2.7X10 ²	7.0X10 ⁻¹	1.9X10 ¹	1.7X10 ¹	4.6X10 ²
Tm-167	Thulium (69)	7.0	1.9X10 ²	8.0X10 ⁻¹	2.2X10 ¹	3.1X10 ³	8.5X10 ⁴
Tm-170		3.0	8.1X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.2X10 ²	6.0X10 ³
Tm-171		4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³
U-230 (fast lung absorption) (a)(d)	Uranium (92)	4.0X10 ¹	1.1X10 ³	1.0X10 ⁻¹	2.7	1.0X10 ³	2.7X10 ⁴
U-230 (medium lung absorption) (a)(e)		4.0X10 ¹	1.1X10 ³	4.0X10 ⁻³	1.1X10 ⁻¹	1.0X10 ³	2.7X10 ⁴
U-230 (slow lung absorption) (a)(f)		3.0X10 ¹	8.1X10 ²	3.0X10 ⁻³	8.1X10 ⁻²	1.0X10 ³	2.7X10 ⁴
U-232 (fast lung absorption) (d)		4.0X10 ¹	1.1X10 ³	1.0X10 ⁻²	2.7X10 ⁻¹	8.3X10 ⁻¹	2.2X10 ¹
U-232 (medium lung absorption) (e)		4.0X10 ¹	1.1X10 ³	7.0X10 ⁻³	1.9X10 ⁻¹	8.3X10 ⁻¹	2.2X10 ¹
U-232 (slow lung absorption) (f)		1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	8.3X10 ⁻¹	2.2X10 ¹
U-233 (fast lung absorption) (d)		4.0X10 ¹	1.1X10 ³	9.0X10 ⁻²	2.4	3.6X10 ⁻⁴	9.7X10 ⁻³

Symbol of radionuclide	Element and atomic number	A1 (TBq)	A1 (Ci) ^b	A2 (TBq)	A2 (Ci) ^b	Specific activity	
						(TBq/g)	(Ci/g)
U-233 (medium lung absorption) (e)		4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	3.6X10 ⁻⁴	9.7X10 ⁻³
U-233 (slow lung absorption) (f)		4.0X10 ¹	1.1X10 ³	6.0X10 ⁻³	1.6X10 ⁻¹	3.6X10 ⁻⁴	9.7X10 ⁻³
U-234 (fast lung absorption) (d)		4.0X10 ¹	1.1X10 ³	9.0X10 ⁻²	2.4	2.3X10 ⁻⁴	6.2X10 ⁻³
U-234 (medium lung absorption) (e)		4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	2.3X10 ⁻⁴	6.2X10 ⁻³
U-234 (slow lung absorption) (f)		4.0X10 ¹	1.1X10 ³	6.0X10 ⁻³	1.6X10 ⁻¹	2.3X10 ⁻⁴	6.2X10 ⁻³
U-235 (all lung absorption types) (a), (d), (e), (f)		Unlimited	Unlimited	Unlimited	Unlimited	8.0X10 ⁻⁸	2.2X10 ⁻⁶
U-236 (fast lung absorption) (d)		Unlimited	Unlimited	Unlimited	Unlimited	2.4X10 ⁻⁶	6.5X10 ⁻⁵
U-236 (medium lung absorption) (e)		4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	2.4X10 ⁻⁶	6.5X10 ⁻⁵
U-236 (slow lung absorption) (f)		4.0X10 ¹	1.1X10 ³	6.0X10 ⁻³	1.6X10 ⁻¹	2.4X10 ⁻⁶	6.5X10 ⁻⁵
U-238 (all lung absorption types) (d), (e), (f)		Unlimited	Unlimited	Unlimited	Unlimited	1.2X10 ⁻⁸	3.4X10 ⁻⁷
U (nat)		Unlimited	Unlimited	Unlimited	Unlimited	2.6X10 ⁻⁸	7.1X10 ⁻⁷
U (enriched to 20% or less) (g)		Unlimited	Unlimited	Unlimited	Unlimited	See Table A-4	See Table A-4
U (dep)		Unlimited	Unlimited	Unlimited	Unlimited	See Table A-4	See Table A-3
V-48	Vanadium (23)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	6.3X10 ³	1.7X10 ⁵
V-49		4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	3.0X10 ²	8.1X10 ³
W-178 (a)	Tungsten (74)	9.0	2.4X10 ²	5.0	1.4X10 ²	1.3X10 ³	3.4X10 ⁴
W-181		3.0X10 ¹	8.1X10 ²	3.0X10 ¹	8.1X10 ²	2.2X10 ²	6.0X10 ³
W-185		4.0X10 ¹	1.1X10 ³	8.0X10 ⁻¹	2.2X10 ¹	3.5X10 ²	9.4X10 ³
W-187		2.0	5.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.6X10 ¹	7.0X10 ²
W-188 (a)		4.0X10 ⁻¹	1.1X10 ¹	3.0X10 ⁻¹	8.1	3.7X10 ²	1.0X10 ⁴
Xe-122 (a)	Xenon (54)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	4.8X10 ⁴	1.3X10 ⁶
Xe-123		2.0	5.4X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	4.4X10 ⁵	1.2X10 ⁷
Xe-127		4.0	1.1X10 ²	2.0	5.4X10 ¹	1.0X10 ³	2.8X10 ⁴
Xe-131m		4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	3.1X10 ³	8.4X10 ⁴
Xe-133		2.0X10 ¹	5.4X10 ²	1.0X10 ¹	2.7X10 ²	6.9X10 ³	1.9X10 ⁵
Xe-135		3.0	8.1X10 ¹	2.0	5.4X10 ¹	9.5X10 ⁴	2.6X10 ⁶
Y-87 (a)	Yttrium (39)	1.0	2.7X10 ¹	1.0	2.7X10 ¹	1.7X10 ⁴	4.5X10 ⁵
Y-88		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	5.2X10 ²	1.4X10 ⁴
Y-90		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	2.0X10 ⁴	5.4X10 ⁵
Y-91		6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	9.1X10 ²	2.5X10 ⁴
Y-91m		2.0	5.4X10 ¹	2.0	5.4X10 ¹	1.5X10 ⁶	4.2X10 ⁷
Y-92		2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	3.6X10 ⁵	9.6X10 ⁶
Y-93		3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.2X10 ⁵	3.3X10 ⁶
Yb-169	Ytterbium (70)	4.0	1.1X10 ²	1.0	2.7X10 ¹	8.9X10 ²	2.4X10 ⁴
Yb-175		3.0X10 ¹	8.1X10 ²	9.0X10 ⁻¹	2.4X10 ¹	6.6X10 ³	1.8X10 ⁵
Zn-65	Zinc (30)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	3.0X10 ²	8.2X10 ³
Zn-69		3.0	8.1X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.8X10 ⁶	4.9X10 ⁷
Zn-69m (a)		3.0	8.1X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.2X10 ⁵	3.3X10 ⁶
Zr-88	Zirconium (40)	3.0	8.1X10 ¹	3.0	8.1X10 ¹	6.6X10 ²	1.8X10 ⁴
Zr-93		Unlimited	Unlimited	Unlimited	Unlimited	9.3X10 ⁻⁵	2.5X10 ⁻³
Zr-95 (a)		2.0	5.4X10 ¹	8.0X10 ⁻¹	2.2X10 ¹	7.9X10 ²	2.1X10 ⁴
Zr-97 (a)		4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	7.1X10 ⁴	1.9X10 ⁶

(a)	A ₁ or A ₂ values include contributions from daughter nuclides with half-lives less than ten days, as listed in the following:	
	Mg-28	Al-28
	Ca-47	Sc-47
	Ti-44	Sc-44
	Fe-52	Mn-52m
	Fe-60	Co-60m
	Zn-69m	Zn-69
	Ge-68	Ga-68

	Rb-83	Kr-83m
	Sr-82	Rb-82
	Sr-90	Y-90
	Sr-91	Y-91m
	Sr-92	Y-92
	Y-87	Sr-87m
	Zr-95	Nb-95m
	Zr-97	Nb-97m, Nb-97
	Mo-99	Tc-99m
	Tc-95m	Tc-95
	Tc-96m	Tc-96
	Ru-103	Rh-103m
	Ru-106	Rh-106
	Pd-103	Rh-103m
	Ag-108m	Ag-108
	Ag-110m	Ag-110
	Cd-115	In-115m
	In-114m	In-114
	Sn-113	In-113m
	Sn-121m	Sn-121
	Sn-126	Sb-126m
	Te-127m	Te-127
	Te-129m	Te-129
	Te-131m	Te-131
	Te-132	I-132
	I-135	Xe-135m
	Xe-122	I-122
	Cs-137	Ba-137m
	Ba-131	Cs-131
	Ba-140	La-140
	Ce-144	Pr-144m, Pr-144
	Pm-148m	Pm-148
	Gd-146	Eu-146
	Dy-166	Ho-166
	Hf-172	Lu-172
	W-178	Ta-178
	W-188	Re-188
	Re-189	Os-189m
	Os-194	Ir-194
	Ir-189	Os-189m
	Pt-188	Ir-188
	Hg-194	Au-194
	Hg-195m	Hg-195
	Pb-210	Bi-210
	Pb-212	Bi-212, Tl-208, Po-212
	Bi-210m	Tl-206
	Bi-212	Tl-208, Po-212
	At-211	Po-211
	Rn-222	Po-218, Pb-214, At-218, Bi-214, Po-214
	Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
	Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
	Ra-225	Ac-225, Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
	Ra-226	Rn-222, Po-218, Pb-214, At-218, Bi-214, Po-214
	Ra-228	Ac-228
	Ac-225	Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
	Ac-227	Fr-223
	Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
	Th-234	Pa-234m, Pa-234
	Pa-230	Ac-226, Th-226, Fr-222, Ra-222, Rn-218, Po-214
	U-230	Th-226, Ra-222, Rn-218, Po-214
	U-235	Th-231
	Pu-241	U-237
	Pu-244	U-240, Np-240m
	Am-242m	Am-242, Np-238
	Am-243	Np-239
	Cm-247	Pu-243
	Bk-249	Am-245
	Cf-253	Cm-249
	Am-243	Np-239
	Cm-247	Pu-243
	Bk-249	Am-245
	Cf-253	Cm-249
(b)	The values of A_1 and A_2 in Curies (Ci) are approximate and for information only the regulatory standard units are terabecquerels (TBq).	
(c)	The activity of IR-192 in special form may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed distance from the source.	
(d)	These values apply only to compounds of uranium that take the chemical form of UF_6 , UO_2F_2 and $UO_2(NO_3)_2$ in both normal and accident conditions of transport.	
(e)	These values apply only to compounds of uranium that take the chemical form of UO_3 , UF_4 , UCl_4 and hexavalent compounds in both normal and accident conditions of transport.	
(f)	These values apply to all compounds of uranium other than those specified in notes (d) and (e) of this table.	
(g)	These values apply to unirradiated uranium only.	
(h)	$A_2 = 0.74$ TBq (20 Ci) for Mo-99 for domestic use.	

Table A-2.—Exempt Material Activity Concentrations and Exempt Consignment Activity

Limits for Radionuclides

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Ac-225	Actinium (89)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
Ac-227	-	1.0X10 ⁻¹	2.7X10 ⁻¹²	1.0X10 ³	2.7X10 ⁻⁸
Ac-228	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻³
Ag-105	Silver (47)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻³
Ag-108m (b)	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻³
Ag-110m	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻³
Ag-111	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻³
Al-26	Aluminum (13)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Am-241	Americium (95)	1.0	2.7X10 ⁻¹¹	1.0X10 ⁴	2.7X10 ⁻⁷
Am-242m (b)	-	1.0	2.7X10 ⁻¹¹	1.0X10 ⁴	2.7X10 ⁻⁷
Am-243 (b)	-	1.0	2.7X10 ⁻¹¹	1.0X10 ³	2.7X10 ⁻⁸
Ar-37	Argon (18)	1.0X10 ⁶	2.7X10 ⁻⁵	1.0X10 ⁸	2.7X10 ⁻³
Ar-39	-	1.0X10 ⁷	2.7X10 ⁻⁴	1.0X10 ⁴	2.7X10 ⁻⁷
Ar-41	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁹	2.7X10 ⁻²
As-72	Arsenic (33)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
As-73	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
As-74	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻³
As-76	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
As-77	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻³
At-211	Astatine (85)	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Au-193	Gold (79)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Au-194	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻³
Au-195	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Au-198	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻³
Au-199	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻³
Ba-131	Barium (56)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻³
Ba-133	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻³
Ba-133m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻³
Ba-140 (b)	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Be-7	Beryllium (4)	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Be-10	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁶	2.7X10 ⁻³
Bi-205	Bismuth (83)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻³
Bi-206	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Bi-207	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻³
Bi-210	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻³
Bi-210m	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Bi-212 (b)	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Bk-247	Berkelium (97)	1.0	2.7X10 ⁻¹¹	1.0X10 ⁴	2.7X10 ⁻⁷
Bk-249	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻³
Br-76	Bromine (35)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Br-77	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻³
Br-82	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻³
C-11	Carbon (6)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻³
C-14	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁻⁴
Ca-41	Calcium (20)	1.0X10 ⁵	2.7X10 ⁻⁶	1.0X10 ⁷	2.7X10 ⁻⁴
Ca-45	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁻⁴
Ca-47	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻³
Cd-109	Cadmium (48)	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁶	2.7X10 ⁻³
Cd-113m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻³

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Cd-115	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Cd-115m	-	1.0X10 ³	2.7X10 ⁸	1.0X10 ⁶	2.7X10 ⁵
Ce-139	Cerium (58)	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Ce-141	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁷	2.7X10 ⁴
Ce-143	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Ce-144 (b)	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁵	2.7X10 ⁶
Cf-248	Californium (98)	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁴	2.7X10 ⁷
Cf-249	-	1.0	2.7X10 ¹¹	1.0X10 ³	2.7X10 ⁸
Cf-250	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁴	2.7X10 ⁷
Cf-251	-	1.0	2.7X10 ¹¹	1.0X10 ³	2.7X10 ⁸
Cf-252	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁴	2.7X10 ⁷
Cf-253	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁵	2.7X10 ⁶
Cf-254	-	1.0	2.7X10 ¹¹	1.0X10 ³	2.7X10 ⁸
Cl-36	Chlorine (17)	1.0X10 ⁴	2.7X10 ⁷	1.0X10 ⁶	2.7X10 ⁵
Cl-38	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁵	2.7X10 ⁶
Cm-240	Curium (96)	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁵	2.7X10 ⁶
Cm-241	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Cm-242	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁵	2.7X10 ⁶
Cm-243	-	1.0	2.7X10 ¹¹	1.0X10 ⁴	2.7X10 ⁷
Cm-244	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁴	2.7X10 ⁷
Cm-245	-	1.0	2.7X10 ¹¹	1.0X10 ³	2.7X10 ⁸
Cm-246	-	1.0	2.7X10 ¹¹	1.0X10 ³	2.7X10 ⁸
Cm-247	-	1.0	2.7X10 ¹¹	1.0X10 ⁴	2.7X10 ⁷
Cm-248	-	1.0	2.7X10 ¹¹	1.0X10 ³	2.7X10 ⁸
Co-55	Cobalt (27)	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁶	2.7X10 ⁵
Co-56	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁵	2.7X10 ⁶
Co-57	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Co-58	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁶	2.7X10 ⁵
Co-58m	-	1.0X10 ⁴	2.7X10 ⁷	1.0X10 ⁷	2.7X10 ⁴
Co-60	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁵	2.7X10 ⁶
Cr-51	Chromium (24)	1.0X10 ³	2.7X10 ⁸	1.0X10 ⁷	2.7X10 ⁴
Cs-129	Cesium (55)	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁵	2.7X10 ⁶
Cs-131	-	1.0X10 ³	2.7X10 ⁸	1.0X10 ⁶	2.7X10 ⁵
Cs-132	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁵	2.7X10 ⁶
Cs-134	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁴	2.7X10 ⁷
Cs-134m	-	1.0X10 ³	2.7X10 ⁸	1.0X10 ⁵	2.7X10 ⁶
Cs-135	-	1.0X10 ⁴	2.7X10 ⁷	1.0X10 ⁷	2.7X10 ⁴
Cs-136	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁵	2.7X10 ⁶
Cs-137 (b)	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁴	2.7X10 ⁷
Cu-64	Copper (29)	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Cu-67	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Dy-159	Dysprosium (66)	1.0X10 ³	2.7X10 ⁸	1.0X10 ⁷	2.7X10 ⁴
Dy-165	-	1.0X10 ³	2.7X10 ⁸	1.0X10 ⁶	2.7X10 ⁵
Dy-166	-	1.0X10 ³	2.7X10 ⁸	1.0X10 ⁶	2.7X10 ⁵
Er-169	Erbium (68)	1.0X10 ⁴	2.7X10 ⁷	1.0X10 ⁷	2.7X10 ⁴
Er-171	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Eu-147	Europium (63)	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Eu-148	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁶	2.7X10 ⁵
Eu-149	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁷	2.7X10 ⁴
Eu-150 (short lived)	-	1.0X10 ³	2.7X10 ⁸	1.0X10 ⁶	2.7X10 ⁵
Eu-150 (long lived)	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁶	2.7X10 ⁵
Eu-152	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁶	2.7X10 ⁵
Eu-152m	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Eu-154	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁶	2.7X10 ⁵
Eu-155	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁷	2.7X10 ⁴

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Eu-156	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
F-18	Fluorine (9)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Fe-52	Iron (26)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Fe-55	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁶	2.7X10 ⁵
Fe-59	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Fe-60	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁶
Ga-67	Gallium (31)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Ga-68	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁶
Ga-72	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁶
Gd-146	Gadolinium (64)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Gd-148	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁷
Gd-153	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁴
Gd-159	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁵
Ge-68	Germanium (32)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁶
Ge-71	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁸	2.7X10 ⁻³
Ge-77	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁶
Hf-172	Hafnium (72)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Hf-175	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Hf-181	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Hf-182	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Hg-194	Mercury (80)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Hg-195m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Hg-197	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁴
Hg-197m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Hg-203	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁶
Ho-166	Holmium (67)	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁶
Ho-166m	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
I-123	Iodine (53)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁴
I-124	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
I-125	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁵
I-126	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
I-129	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁶
I-131	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
I-132	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁶
I-133	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
I-134	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁶
I-135	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
In-111	Indium (49)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
In-113m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
In-114m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
In-115m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Ir-189	Iridium (77)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁴
Ir-190	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Ir-192	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁷
Ir-194	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁶
K-40	Potassium (19)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
K-42	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
K-43	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Kr-79	Krypton (36)	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁶
Kr-81		1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁴
Kr-85	-	1.0X10 ⁵	2.7X10 ⁻⁶	1.0X10 ⁴	2.7X10 ⁷
Kr-85m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ¹⁰	2.7X10 ¹
Kr-87	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ³
La-137	Lanthanum (57)	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁴
La-140	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁶

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Lu-172	Lutetium (71)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Lu-173	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁴
Lu-174	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁴
Lu-174m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁴
Lu-177	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁴
Mg-28	Magnesium (12)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Mn-52	Manganese (25)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Mn-53	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁹	2.7X10 ²
Mn-54	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Mn-56	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Mo-93	Molybdenum (42)	1.0X10 ²	2.7X10 ⁻⁸	1.0X10 ⁸	2.7X10 ³
Mo-99	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
N-13	Nitrogen (7)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁹	2.7X10 ²
Na-22	Sodium (11)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Na-24	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Nb-93m	Niobium (41)	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁴
Nb-94	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Nb-95	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Nb-97	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Nd-147	Neodymium (60)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Nd-149	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Ni-59	Nickel (28)	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁸	2.7X10 ³
Ni-63	-	1.0X10 ⁵	2.7X10 ⁻⁶	1.0X10 ⁸	2.7X10 ³
Ni-65	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Np-235	Neptunium (93)	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁴
Np-236 (short-lived)	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁴
Np-236 (long-lived)	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Np-237 (b)	-	1.0	2.7X10 ⁻¹¹	1.0X10 ³	2.7X10 ⁸
Np-239	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁴
Os-185	Osmium (76)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Os-191	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁴
Os-191m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁴
Os-193	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Os-194	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
P-32	Phosphorus (15)	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁵	2.7X10 ⁶
P-33	-	1.0X10 ⁵	2.7X10 ⁻⁶	1.0X10 ⁸	2.7X10 ³
Pa-230	Protactinium (91)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Pa-231	-	1.0	2.7X10 ⁻¹¹	1.0X10 ³	2.7X10 ⁸
Pa-233	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁴
Pb-201	Lead (82)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Pb-202	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁵
Pb-203	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Pb-205	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁴
Pb-210 (b)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁷
Pb-212 (b)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁶
Pd-103	Palladium (46)	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁸	2.7X10 ³
Pd-107	-	1.0X10 ⁵	2.7X10 ⁻⁶	1.0X10 ⁸	2.7X10 ³
Pd-109	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁵
Pm-143	Promethium (61)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵
Pm-144	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Pm-145	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁴
Pm-147	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁴
Pm-148m	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁵
Pm-149	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁵
Pm-151	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁵

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Po-210	Polonium (84)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
Pr-142	Praseodymium (59)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
Pr-143	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁶	2.7X10 ⁻⁵
Pt-188	Platinum (78)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Pt-191	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Pt-193	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁻⁴
Pt-193m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Pt-195m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Pt-197	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻⁵
Pt-197m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Pu-236	Plutonium (94)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
Pu-237	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Pu-238	-	1.0	2.7X10 ⁻¹¹	1.0X10 ⁴	2.7X10 ⁻⁷
Pu-239	-	1.0	2.7X10 ⁻¹¹	1.0X10 ⁴	2.7X10 ⁻⁷
Pu-240	-	1.0	2.7X10 ⁻¹¹	1.0X10 ³	2.7X10 ⁻⁸
Pu-241	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
Pu-242	-	1.0	2.7X10 ⁻¹¹	1.0X10 ⁴	2.7X10 ⁻⁷
Pu-244	-	1.0	2.7X10 ⁻¹¹	1.0X10 ⁴	2.7X10 ⁻⁷
Ra-223 (b)	Radium (88)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
Ra-224 (b)	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Ra-225	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
Ra-226 (b)	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
Ra-228 (b)	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Rb-81	Rubidium (37)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Rb-83	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Rb-84	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Rb-86	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
Rb-87	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁻⁴
Rb (nat)	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁻⁴
Re-184	Rhenium (75)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Re-184m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Re-186	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻⁵
Re-187	-	1.0X10 ⁶	2.7X10 ⁻⁵	1.0X10 ⁷	2.7X10 ⁻²
Re-188	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
Re-189	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Re (nat)	-	1.0X10 ⁶	2.7X10 ⁻⁵	1.0X10 ⁷	2.7X10 ⁻²
Rh-99	Rhodium (45)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Rh-101	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Rh-102	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Rh-102m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Rh-103m	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁸	2.7X10 ⁻³
Rh-105	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Rn-222 (b)	Radon (86)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁸	2.7X10 ⁻³
Ru-97	Ruthenium (44)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Ru-103	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Ru-105	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Ru-106 (b)	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
S-35	Sulphur (16)	1.0X10 ⁵	2.7X10 ⁻⁶	1.0X10 ⁸	2.7X10 ⁻³
Sb-122	Antimony (51)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁴	2.7X10 ⁻⁷
Sb-124	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Sb-125	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Sb-126	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Sc-44	Scandium (21)	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Sc-46	-	1.0X10 ⁰	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Sc-47	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Sc-48	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Se-75	Selenium (34)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Se-79	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁻⁴
Si-31	Silicon (14)	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻⁵
Si-32	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻⁵
Sm-145	Samarium (62)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Sm-147	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
Sm-151	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁸	2.7X10 ⁻³
Sm-153	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Sn-113	Tin (50)	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Sn-117m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Sn-119m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Sn-121m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Sn-123	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻⁵
Sn-125	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
Sn-126	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Sr-82	Strontium (38)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Sr-85	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Sr-85m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Sr-87m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Sr-89	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻⁵
Sr-90 (b)	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁴	2.7X10 ⁻⁷
Sr-91	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Sr-92	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
T(H-3)	Tritium (1)	1.0X10 ⁶	2.7X10 ⁻⁵	1.0X10 ⁹	2.7X10 ⁻²
Ta-178 (long-lived)	Tantalum (73)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Ta-179	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Ta-182	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
Tb-157	Terbium (65)	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁻⁴
Tb-158	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Tb-160	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Tc-95m	Technetium (43)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Tc-96	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Tc-96m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Tc-97	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁸	2.7X10 ⁻³
Tc-97m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Tc-98	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Tc-99	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁻⁴
Tc-99m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Te-121	Tellurium (52)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Te-121m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Te-123m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Te-125m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Te-127	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻⁵
Te-127m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Te-129	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Te-129m	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻⁵
Te-131m	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Te-132	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Th-227	Thorium (90)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
Th-228 (b)	-	1.0	2.7X10 ⁻¹¹	1.0X10 ⁴	2.7X10 ⁻⁷
Th-229 (b)	-	1.0	2.7X10 ⁻¹¹	1.0X10 ⁵	2.7X10 ⁻⁸
Th-230	-	1.0	2.7X10 ⁻¹¹	1.0X10 ⁴	2.7X10 ⁻⁷
Th-231	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Th-232	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Th-234 (b)	-	1.0X10 ⁵	2.7X10 ⁻⁸	1.0X10 ⁵	2.7X10 ⁻⁶
Th (nat) (b)	-	1.0	2.7X10 ⁻¹¹	1.0X10 ³	2.7X10 ⁻⁸
Ti-44	Titanium (22)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
Tl-200	Thallium (81)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Tl-201	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Tl-202	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Tl-204	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁴	2.7X10 ⁻⁷
Tm-167	Thulium (69)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Tm-170	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻⁵
Tm-171	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁸	2.7X10 ⁻³
U-230 (fast lung absorption) (b), (d)	Uranium (92)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
U-230 (medium lung absorption) (e)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
U-230 (slow lung absorption) (f)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
U-232 (fast lung absorption) (b), (d)	-	1.0	2.7X10 ⁻¹¹	1.0X10 ³	2.7X10 ⁻⁸
U-232 (medium lung absorption) (e)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
U-232 (slow lung absorption) (f)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
U-233 (fast lung absorption) (d)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
U-233 (medium lung absorption) (e)	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
U-233 (slow lung absorption) (f)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
U-234 (fast lung absorption) (d)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
U-234 (medium lung absorption) (e)	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
U-234 (slow lung absorption) (f)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
U-235 (all lung absorption types) (b), (d), (e), (f)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
U-236 (fast lung absorption) (d)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
U-236 (medium lung absorption) (e)	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
U-236 (slow lung absorption) (f)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
U-238 (all lung absorption types) (b), (d), (e), (f)	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁴	2.7X10 ⁻⁷
U (nat) (b)	-	1.0	2.7X10 ⁻¹¹	1.0X10 ³	2.7X10 ⁻⁸
U (enriched to 20% or less) (g)	-	1.0	2.7X10 ⁻¹¹	1.0X10 ³	2.7X10 ⁻⁸
U (dep)	-	1.0	2.7X10 ⁻¹¹	1.0X10 ³	2.7X10 ⁻⁸
V-48	Vanadium (23)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁵	2.7X10 ⁻⁶
V-49	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁻⁴
W-178	Tungsten (74)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
W-181	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
W-185	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁷	2.7X10 ⁻⁴
W-187	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
W-188	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
Xe-122	Xenon (54)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Xe-123	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Xe-127	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁵	2.7X10 ⁻⁶
Xe-131m	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁴	2.7X10 ⁻⁷
Xe-133	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁴	2.7X10 ⁻⁷
Xe-135	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ¹⁰	2.7X10 ⁻¹
Y-87	Yttrium (39)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Y-88	-	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Y-90	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁵	2.7X10 ⁻⁶
Y-91	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁶	2.7X10 ⁻⁵
Y-91m	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁶	2.7X10 ⁻⁵
Y-92	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
Y-93	-	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁵	2.7X10 ⁻⁶
Yb-169	Ytterbium (70)	1.0X10 ²	2.7X10 ⁻⁹	1.0X10 ⁷	2.7X10 ⁻⁴
Yb-175	-	1.0X10 ³	2.7X10 ⁻⁸	1.0X10 ⁷	2.7X10 ⁻⁴
Zn-65	Zinc (30)	1.0X10 ¹	2.7X10 ⁻¹⁰	1.0X10 ⁶	2.7X10 ⁻⁵
Zn-69	-	1.0X10 ⁴	2.7X10 ⁻⁷	1.0X10 ⁶	2.7X10 ⁻⁵

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Zn-69m	-	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Zr-88	Zirconium (40)	1.0X10 ²	2.7X10 ⁹	1.0X10 ⁶	2.7X10 ⁵
Zr-93 (b)	-	1.0X10 ³	2.7X10 ⁸	1.0X10 ⁷	2.7X10 ⁴
Zr-95	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁶	2.7X10 ⁵
Zr-97 (b)	-	1.0X10 ¹	2.7X10 ¹⁰	1.0X10 ⁶	2.7X10 ⁵

- (a) (Reserved)
- (b) Parent nuclides and their progeny included in secular equilibrium are listed as follows:
- | | |
|---------|--|
| Sr-90 | Y-90 |
| Zr-93 | Nb-93m |
| Zr-97 | Nb-97 |
| Ru-106 | Rh-106 |
| Ag-108m | Ag-108 |
| Cs-137 | Ba-137m |
| Ce-144 | Pr-144 |
| Ba-140 | La-140 |
| Bi-212 | Tl-208 (0.36), Po-212 (0.64) |
| Pb-210 | Bi-210, Po-210 |
| Pb-212 | Bi-212, Tl-208 (0.36), Po-212 (0.64) |
| Rn-222 | Po-218, Pb-214, Bi-214, Po-214 |
| Ra-223 | Rn-219, Po-215, Pb-211, Bi-211, Tl-207 |
| Ra-224 | Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) |
| Ra-226 | Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210 |
| Ra-228 | Ac-228 |
| Th-228 | Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) |
| Th-229 | Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209 |
| Th-nat | Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) |
| Th-234 | Pa-234m |
| U-230 | Th-226, Ra-222, Rn-218, Po-214 |
| U-232 | Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) |
| U-235 | Th-231 |
| U-238 | Th-234, Pa-234m |
| U-nat | Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210 |
| Np-237 | Pa-233 |
| Am-242m | Am-242 |
| Am-243 | Np-239 |
- (c) (Reserved)
- (d) These values apply only to compounds of uranium that take the chemical form of UF₆, UO₂F₂ and UO₂(NO₃)₂ in both normal and accident conditions of transport.
- (e) These values apply only to compounds of uranium that take the chemical form of UO₃, UF₄, UCl₄ and hexavalent compounds in both normal and accident conditions of transport.
- (f) These values apply to all compounds of uranium other than those specified in notes (d) and (e) of this table.
- (g) These values apply to unirradiated uranium only.

Table A-3. General Values for A1 and A2

Contents	A ₁		A ₂		Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limits for exempt consignments (Bq)	Activity limits for exempt consignments (Ci)
	(TBq)	(Ci)	(TBq)	(Ci)				
Only beta or gamma emitting radionuclides are known to be present	1 x 10 ⁻¹	2.7 x 10 ⁰	2 x 10 ⁻²	5.4 x 10 ⁻¹	1 x 10 ¹	2.7 x 10 ⁻¹⁰	1 x 10 ⁵	2.7 x 10 ⁻⁷
Alpha emitting nuclides, but no neutron emitters, are known to be present (a)	2 x 10 ⁻¹	5.4 x 10 ⁰	9 x 10 ⁻⁵	2.4 x 10 ⁻³	1 x 10 ⁻¹	2.7 x 10 ⁻¹²	1 x 10 ⁵	2.7 x 10 ⁻⁸
Neutron emitting nuclides are known to be present or no relevant data are available	1 x 10 ⁻³	2.7 x 10 ⁻²	9 x 10 ⁻⁵	2.4 x 10 ⁻³	1 x 10 ⁻¹	2.7 x 10 ⁻¹²	1 x 10 ⁵	2.7 x 10 ⁻⁸

- (a) If beta or gamma emitting nuclides are known to be present, the A₁ value of 0.1 TBq (2.7 Ci) should be used.

Table A-4.
Activity-Mass Relationships for Uranium

Uranium Enrichment ¹ wt % U-235 present	Specific Activity	
	TBq/g	Ci/g

Uranium Enrichment ¹ wt % U-235 present	Specific Activity	
	TBq/g	Ci/g
0.45	1.8 x 10 ⁻⁸	5.0 x 10 ⁻⁷
0.72	2.6 x 10 ⁻⁸	7.1 x 10 ⁻⁷
1	2.8 x 10 ⁻⁸	7.6 x 10 ⁻⁷
1.5	3.7 x 10 ⁻⁸	1.0 x 10 ⁻⁶
5	1.0 x 10 ⁻⁷	2.7 x 10 ⁻⁶
10	1.8 x 10 ⁻⁷	4.8 x 10 ⁻⁶
20	3.7 x 10 ⁻⁷	1.0 x 10 ⁻⁵
35	7.4 x 10 ⁻⁷	2.0 x 10 ⁻⁵
50	9.3 x 10 ⁻⁷	2.5 x 10 ⁻⁵
90	2.2 x 10 ⁻⁶	5.8 x 10 ⁻⁵
93	2.6 x 10 ⁻⁶	7.0 x 10 ⁻⁵
95	3.4 x 10 ⁻⁶	9.1 x 10 ⁻⁵

¹ The figures for uranium include representative values for the activity of the uranium-234 that is concentrated during the enrichment process.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-231-200, filed 12/12/16, effective 1/12/17; WSR 16-13-054, § 246-231-200, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 14-09-017, § 246-231-200, filed 4/7/14, effective 5/8/14; WSR 11-03-068, § 246-231-200, filed 1/18/11, effective 2/18/11; WSR 08-09-093, § 246-231-200, filed 4/18/08, effective 5/19/08; WSR 99-15-105, § 246-231-200, filed 7/21/99, effective 8/21/99.]

Reviser's note: The brackets and enclosed material in the text of the above section occurred in the copy filed by the agency.

Chapter 246-232 WAC

RADIOACTIVE MATERIAL—LICENSING APPLICABILITY

Last Update: 12/12/16

WAC

- 246-232-001 Purpose and scope.
- 246-232-006 Exemption of certain source material.
- 246-232-007 Exemption of certain depleted uranium items.
- 246-232-008 Exemption of certain timepieces, hands or dials.
- 246-232-009 Exemption of certain items containing radioactive material.
- 246-232-010 Exempt concentrations and exempt quantities.
- 246-232-011 Exemption of certain self-luminous products containing radioactive material(s).
- 246-232-012 Exemption of certain gas and aerosol detectors containing radioactive material.
- 246-232-014 Exemption of C-14 urea diagnostic capsules for human use.
- 246-232-015 Certain industrial devices.
- 246-232-020 Types of licenses.
- 246-232-030 Prelicensing inspection.
- 246-232-040 Reciprocal recognition of licenses.
- 246-232-050 Terms and conditions of licenses.
- 246-232-060 Termination of licenses and decommissioning of sites and separate buildings or outdoor areas.

246-232-070 Modification and revocation of licenses.

246-232-080 Transfer of material.

246-232-090 Transportation.

246-232-120 Schedule B, exempt quantities of radioactive materials.

246-232-130 Schedule C, exempt concentrations.

246-232-140 Schedule D.

246-232-990 Fees.

DISPOSITION OF SECTIONS FORMERLY CODIFIED IN THIS CHAPTER

246-232-013 Exemption of certain resins containing scandium-46 and designed for sand consolidation in oil wells. [Statutory Authority: RCW 70.98.050. WSR 01-02-068, § 246-232-013, filed 12/29/00, effective 1/29/01.] Repealed by WSR 13-24-025, filed 11/22/13, effective 12/23/13. Statutory Authority: RCW 70.98.050.

246-232-100 Requirements for users of the Washington commercial low-level waste disposal site. [Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-100, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080 and chapter 70.121 RCW. WSR 86-17-027 (Order 2406), § 402-19-530, filed 8/13/86. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-19-530, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-19-530, filed 12/8/80. Statutory Authority: RCW 70.98.080. WSR 80-02-080 (Order 1481), § 402-19-530, filed 1/21/80.] Repealed by WSR 91-15-112 (Order 184), filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 70.98.050 and 70.98.080.

246-232-110 Large volumes of naturally occurring material. [Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-110, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080 and chapter 70.121 RCW. WSR 86-17-027 (Order 2406), § 402-19-540, filed 8/13/86.] Repealed by WSR 91-15-112 (Order 184), filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 70.98.050 and 70.98.080.

WAC 246-232-001 Purpose and scope. (1) This chapter prescribes rules governing licensing of radioactive material. No person shall manufacture, produce, transfer, receive, acquire, own, possess, or use radioactive material except:

(a) As authorized in a specific or general license issued under chapters 246-233 or 246-235 WAC;

(b) As authorized in a specific or general license issued under regulations of NRC or an agreement state equivalent to chapters 246-233 or 246-235 WAC; or

(c) As otherwise provided in this chapter.

(2) In addition to the requirements of this chapter, and chapters 246-233 or 246-235 WAC, all licensees must comply with chapters 246-220, 246-221, 246-222, 246-231, 246-247, and 246-254 WAC. Licensees engaged in the practice of nuclear medicine are subject to chapter 246-240 WAC, licensees engaged in industrial radiographic operations

are subject to chapter 246-243 WAC, licensees using sealed sources in the healing arts are subject to chapter 246-240 WAC, licensees using radioactive material in well logging and subsurface tracer studies are subject to chapter 246-244 WAC, licensees engaged in land disposal of radioactive waste are subject to chapter 246-250 WAC, and licensees owning or operating uranium or thorium mills and associated mill tailings are subject to chapter 246-252 WAC.

(3) No person may introduce radioactive material into a product or material, knowing or having reason to believe that it will be transferred to persons exempt under this section or other sections or equivalent regulations of the NRC or an agreement state, except in accordance with a specific license issued by the NRC, Washington, D.C. 20555.

[Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-001, filed 11/22/13, effective 12/23/13; WSR 06-05-019, § 246-232-001, filed 2/6/06, effective 3/9/06; WSR 99-15-105, § 246-232-001, filed 7/21/99, effective 8/21/99. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-232-001, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-001, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order

2026), § 402-19-010, filed 9/16/83; WSR 79-12-073 (Order 1459), § 402-19-010, filed 11/30/79, effective 1/1/80. Formerly chapter 402-20 WAC.]

WAC 246-232-006 Exemption of certain source material. (1) A person is exempt from the requirements for a license and from this chapter and chapters 246-233 and 246-235 WAC to the extent that the person receives, possesses, uses, transfers, or delivers, source material in any chemical mixture, compound, solution or alloy in which the source material is by weight less than 1/20 of one percent (0.05 percent) of the mixture, compound, solution, or alloy.

(2) A person is exempt from the requirements for a license and from this chapter and chapters 246-233 and 246-235 WAC to the extent that the person receives, possesses, uses or transfers unrefined and unprocessed ore containing source material, provided such person shall not refine or process such ore unless authorized to do so in a specific license.

(3) A person is exempt from the requirements for a license and from this chapter and chapters 246-221, 246-246, 246-222, 246-233, and 246-235 WAC to the extent that the person receives, possesses, uses or transfers:

(a) Any quantities of thorium contained in:

(i) Incandescent gas mantles;

(ii) Vacuum tubes;

(iii) Welding rods;

(iv) Electric lamps for illuminating purposes if each lamp contains fifty milligrams or less of thorium;

(v) Germicidal lamps, sunlamps and lamps for outdoor or industrial lighting if each lamp contains two grams or less of thorium;

(vi) Rare earth metals and compounds, mixtures, and products containing 0.25 percent or less by weight thorium, uranium, or any combination of these; or

(vii) Personnel neutron dosimeters if each dosimeter contains 1.85 gigabecquerels (50 milligrams) or less of thorium.

(b) Source material contained in the following products:

(i) Glazed ceramic tableware manufactured before August 27, 2013, if the glaze contains twenty percent or less by weight source material;

(ii) Piezoelectric ceramic containing two percent or less by weight source material; and

(iii) Glassware containing not more than two percent by weight source material or, for glassware manufactured before August 27, 2013,

ten percent by weight source material; but not including commercially manufactured glass brick, pane glass, ceramic tile, or other glass or ceramic used in construction.

(c) Photographic film, negatives and prints containing uranium or thorium;

(d) Any finished product or part fabricated of, or containing, tungsten-thorium or magnesium-thorium alloys if the thorium content of the alloy is four percent or less by weight. The exemption contained in this subparagraph shall not be deemed to authorize the chemical, physical or metallurgical treatment or processing of any such product or part;

(e) Thorium or uranium contained in or on finished optical lenses and mirrors, provided that each lens or mirror does not contain more than ten percent by weight of thorium or uranium or, for lenses manufactured before August 27, 2013, thirty percent by weight of thorium. The exemption contained in this subparagraph shall not be deemed to authorize either:

(i) The shaping, grinding or polishing of such lens or mirror or manufacturing processes other than the assembly of such lens or mirror into optical systems and devices without alteration of the lens or mirror; or

(ii) The receipt, possession, use or transfer of thorium or uranium contained in contact lenses, or in spectacles, or in eyepieces in binoculars or other optical instruments.

(f) Uranium contained in detector heads for use in fire detection units if each detector head contains 185 becquerels (0.005 microcuries) or less of uranium; or

(g) Thorium contained in any finished aircraft engine part containing nickel-thoria alloy if:

(i) The thorium is dispersed in the nickel-thoria alloy in the form of finely divided thoria (thorium dioxide); and

(ii) The thorium content in the nickel-thoria alloy is four percent or less by weight.

(4) The exemptions in subsection (3) of this section do not authorize the manufacture of any of the products described.

(5) No person may initially transfer for sale or distribution a product containing source material to persons exempt under this section, or equivalent regulations of an agreement state or the NRC, unless authorized by a license issued under 10 C.F.R. 40.52 to initially transfer such products for sale or distribution.

(a) Persons initially distributing source material in products covered by the exemptions in this section before August 27, 2013,

without specific authorization may continue such distribution for one year beyond this date. Initial distribution may also be continued until NRC takes final action on a pending application for license or license amendment to specifically authorize distribution submitted no later than one year beyond this date.

(b) Persons authorized by an agreement state to manufacture, process, or produce these materials or products containing source material, and persons who import finished products or parts for sale or distribution must be authorized by a license issued under 10 C.F.R. 40.52 for distribution only and are exempt from the requirements of chapters 246-221 and 246-222 WAC, and WAC 246-235-020 (1) and (2).

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-232-006, filed 12/12/16, effective 1/12/17; WSR 16-13-054, § 246-232-006, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-006, filed 11/22/13, effective 12/23/13. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 09-06-003, § 246-232-006, filed 2/18/09, effective 3/21/09. Statutory Authority: RCW 70.98.050. WSR 01-02-068, § 246-232-006, filed 12/29/00, effective 1/29/01.]

WAC 246-232-007 Exemption of certain depleted uranium items. (1)

A person is exempt from the requirements for a license and from this chapter and chapters 246-233 and 246-235 WAC to the extent that the person receives, possesses, uses or transfers:

(a) Depleted uranium contained in counterweights installed in aircraft, rockets, projectiles and missiles, or stored or handled in connection with installation or removal of such counterweights if:

(i) Each counterweight has been impressed with the following legend clearly legible through any plating or other covering: "DEPLETED URANIUM" * ;

(ii) Each counterweight is durably and legibly labeled or marked with the identification of the manufacturer and the statement: "UNAUTHORIZED ALTERATIONS PROHIBITED" * ; and

(iii) The exemption contained in this subparagraph shall not be deemed to authorize the chemical, physical or metallurgical treatment or processing of any such counterweight other than repair or restoration of any plating or other covering.

*Note: The requirements specified in (1)(a)(i) and (ii) of this subsection need not be met by counterweights manufactured prior to December 31, 1969, provided that such counterweights are impressed with the legend, "CAUTION - RADIOACTIVE MATERIAL - URANIUM," as previously required by the rules and were manufactured under a specific license issued by the Atomic Energy Commission and were impressed with the legend required by WAC 246-232-007 (1)(a)(i) in effect on June 30, 1969.

(b) Natural or depleted uranium used as shielding constituting part of any shipping container which is conspicuously and legibly im-

pressed with the legend "CAUTION - RADIOACTIVE SHIELDING - URANIUM" and the uranium metal is encased in mild steel or in an equally fire resistant metal of a minimum wall thickness of 3.2 millimeters.

(2) The exemptions in this subsection do not authorize the manufacture of any of the products described.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-232-007, filed 12/12/16, effective 1/12/17; WSR 16-13-054, § 246-232-007, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-007, filed 11/22/13, effective 12/23/13; WSR 01-02-068, § 246-232-007, filed 12/29/00, effective 1/29/01.]

WAC 246-232-008 Exemption of certain timepieces, hands or dials.

A person is exempt from the requirements for a license and from this chapter and chapters 246-233 and 246-235 WAC to the extent that the person receives, possesses, uses, transfers, owns or acquires, and does not apply radioactive material to, or incorporate radioactive material into, the following timepieces or hands or dials containing not more than the following specified quantities of radioactive material and not exceeding the following specified levels of radiation*:

*Note: No person may introduce radioactive material into a product or material, knowing or having reason to believe that it will be transferred to persons exempt under this section or other sections or equivalent regulations of the NRC or an agreement state, except in accordance with a specific license issued by the NRC, Washington, D.C. 20555.

(1)(a) 925 megabecquerels (25 millicuries) of tritium per timepiece;

(b) 185 megabecquerels (5 millicuries) of tritium per hand;

(c) 555 megabecquerels (15 millicuries) of tritium per dial (bezels when used shall be considered as part of the dial);

(d) 3.7 megabecquerels (100 microcuries) of promethium-147 per watch or 7.4 megabecquerels (200 microcuries) of promethium-147 per any other timepiece;

(e) 740 kilobecquerels (20 microcuries) of promethium-147 per watch hand or 1.48 megabecquerels (40 microcuries) of promethium-147 per other timepiece hand;

(f) 2.22 megabecquerels (60 microcuries) of promethium-147 per watch dial or 4.44 megabecquerels (120 microcuries) of promethium-147 per other timepiece dial (bezels when used shall be considered as part of the dial);

(2) The levels of radiation from hands and dials containing promethium-147 will not exceed, when measured through 50 milligrams per square centimeter of absorber:

(a) For wrist watches, 1 microgray (0.1 millirad) per hour at 10 centimeters from any surface;

(b) For pocket watches, 1 microgray (0.1 millirad) per hour at 1 centimeter from any surface;

(c) For any other timepiece, 2 micrograys (0.2 millirad) per hour at 10 centimeters from any surface.

(3) 37 kilobecquerels (1 microcurie) of radium-226 per timepiece in intact timepieces manufactured prior to November 30, 2007.

[Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-008, filed 11/22/13, effective 12/23/13. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 09-06-003, § 246-232-008, filed 2/18/09, effective 3/21/09. Statutory Authority: RCW 70.98.050. WSR 01-02-068, § 246-232-008, filed 12/29/00, effective 1/29/01.]

WAC 246-232-009 Exemption of certain items containing radioactive material. A person is exempt from the requirements for a license and from this chapter and chapters 246-233 and 246-235 WAC to the extent the person receives, possesses, uses, transfers, owns or acquires, and does not apply radioactive material to, or incorporate radioactive material into, the following products:*

*Note: No person may introduce radioactive material into a product or material, knowing or having reason to believe that it will be transferred to persons exempt under this section or other sections or equivalent regulations of the NRC or an agreement state, except in accordance with a specific license issued by the NRC, Washington, D.C. 20555.

(1) Static elimination devices which contain, as a sealed source or sources, by-product material consisting of a total of not more than 18.5 MBq (500 microcuries) of Po-210 per device.

(2)(a) Ion generating tubes designed for ionization of air that contain, as a sealed source or sources, by-product material consisting of a total of not more than 18.5 MBq (500 microcuries) of Po-210 per device or a total of not more than 1.85 GBq (50 millicuries) of hydrogen-3 (tritium) per device.

(b) Such devices authorized before October 23, 2012, for use under the general license then provided in this section and equivalent regulations of an agreement state or the NRC, and manufactured, tested, and labeled by the manufacturer in accordance with the specifications contained in a specific license issued by the department, an agreement state, or the NRC.

(3) Balances of precision containing not more than 37 megabecquerels (1 millicurie) of tritium per balance or 18.5 megabecquerels (0.5 millicurie) of tritium per balance part manufactured before December 17, 2007.

(4) Marine compasses containing not more than 27.8 gigabecquerels (750 millicuries) of tritium gas and other marine navigational instru-

ments containing not more than 9.25 gigabecquerels (250 millicuries) of tritium gas manufactured before December 17, 2007.

(5) Ionization chamber smoke detectors containing not more than 37 kilobecquerels (1 microcurie) of americium-241 per detector in the form of a foil and designed to protect life and property from fires.

(6) Electron tubes* provided that each tube contains no more than one of the following specified quantities of radioactive material and the levels of radiation from each electron tube do not exceed 10 micrograys (1 millirad) per hour at 1 centimeter from any surface when measured through 7 milligrams per square centimeter of absorber:

(a) 5.55 gigabecquerels (150 millicuries) of tritium per microwave receiver protector tube or 370 megabecquerels (10 millicuries) of tritium per any other electron tube;

(b) 37 kilobecquerels (1 microcurie) of cobalt-60;

(c) 185 kilobecquerels (5 microcuries) of nickel-63;

(d) 1.11 megabecquerels (30 microcuries) of krypton-85;

(e) 185 kilobecquerels (5 microcuries) of cesium-137;

(f) 1.11 megabecquerels (30 microcuries) of promethium-147.

*Note: For purposes of this subsection, "electron tubes" include spark gap tubes, power tubes, gas tubes including glow lamps, receiving tubes, microwave tubes, indicator tubes, pick-up tubes, radiation detection tubes, and any other completely sealed tube that is designed to conduct or control electrical currents.

(7) Ionizing radiation measuring instruments containing, for purposes of internal calibration or standardization, one or more sources of radioactive material, provided that:

(a) Each source contains not more than one exempt quantity set forth in WAC 246-232-120, Schedule B, exempt quantities of radioactive materials; and

(b) Each instrument contains no more than 10 exempt quantities. For purposes of this subsection, an instrument's source(s) may contain either one type or different types of radionuclides and an individual exempt quantity may be composed of fractional parts of one or more of the exempt quantities in WAC 246-232-120, Schedule B, exempt quantities of radioactive materials, provided that the sum of such fractions must not exceed unity.

(c) For purposes of this subsection, 1.85 kilobecquerels (0.05 microcurie) of americium-241 is considered an exempt quantity.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-232-009, filed 12/12/16, effective 1/12/17. Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-009, filed 11/22/13, effective 12/23/13. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 09-06-003, § 246-232-009, filed 2/18/09, effective 3/21/09. Statutory Au-

thority: RCW 70.98.050. WSR 01-02-068, § 246-232-009, filed 12/29/00, effective 1/29/01.]

WAC 246-232-010 Exempt concentrations and exempt quantities. This section shall not be deemed to authorize the import of radioactive material or products containing radioactive material.

(1) Exempt concentrations.

(a) Except as provided in (b) of this subsection, a person is exempt from the requirements for a license and from this chapter and chapters 246-233 and 246-235 WAC to the extent that the person receives, possesses, uses, transfers, owns or acquires, and does not apply radioactive material to, or incorporate radioactive material into, products or materials containing radioactive material in concentrations in excess of those in WAC 246-232-130, Schedule C, exempt concentrations.

(b) No person may introduce radioactive material into a product or material knowing, or having reason to believe, that it will be transferred to persons exempt under this section or equivalent regulations of the NRC or an agreement state, except in accordance with a specific license issued by the NRC, Washington, D.C. 20555.

(c) A manufacturer, processor, or producer of a product or material is exempt from the requirements for a license and from this chapter and chapters 246-233 and 246-235 WAC to the extent that this person transfers radioactive material contained in a product or material in concentrations not in excess of those specified in WAC 246-232-130, Schedule C, and introduced into the product or material by a licensee holding a specific license issued by the NRC expressly authorizing such manufacture or introduction. This exemption does not apply to the transfer of radioactive material contained in any food, beverage, cosmetic, drug, or other commodity or product designed for ingestion or inhalation by, or application to, a human being.

(2) Exempt quantities.

(a)(i) Except as provided in (b) through (d) of this subsection, any person is exempt from the requirements for a license and from this chapter and chapters 246-233 and 246-235 WAC to the extent that such person receives, possesses, uses, transfers, owns, or acquires, and does not apply radioactive material to, or incorporate radioactive material into, radioactive material in individual quantities, each of which does not exceed the applicable quantity set forth in WAC 246-232-120, Schedule B, exempt quantities of radioactive materials.

(ii) Any person who possesses radioactive material received or acquired under the general license is exempt from the requirements for a license set forth in chapters 246-333, 246-235 WAC, and this chapter to the extent that such person uses, transfers, or owns such radioactive material. Such exemption does not apply for Radium-226.

(b) This subsection does not authorize the production, packaging, repackaging, or transfer of radioactive material for the purposes of commercial distribution, or the incorporation of radioactive material into products intended for commercial distribution.

(c) No person may, for purposes of commercial distribution, transfer radioactive material in the individual quantities set forth in WAC 246-232-120, Schedule B, exempt quantities of radioactive materials, knowing or having reason to believe that such quantities of radioactive material will be transferred to persons exempt under this section or equivalent rules of the NRC or an agreement state, except in accordance with a specific license issued by the NRC, Washington, D.C. 20555.

(d) No person may, for purposes of producing an increased radiation level, combine quantities of radioactive material covered by this exemption so that the aggregate quantity exceeds the limits set forth in WAC 246-232-120, Schedule B, exempt quantities of radioactive mate-

rials, except for radioactive material combined within a device placed in use before May 3, 1999, or as otherwise permitted by these rules.

[Statutory Authority: RCW 70.98.050. WSR 15-06-015, § 246-232-010, filed 2/23/15, effective 3/26/15; WSR 13-24-025, § 246-232-010, filed 11/22/13, effective 12/23/13; WSR 01-02-068, § 246-232-010, filed 12/29/00, effective 1/29/01; WSR 98-13-037, § 246-232-010, filed 6/8/98, effective 7/9/98. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-232-010, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-010, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-19-190, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-19-190, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-19-190, filed 12/8/80. Statutory Authority: RCW 70.98.080. WSR 79-12-073 (Order 1459), § 402-19-190, filed 11/30/79, effective 1/1/80. Formerly WAC 402-20-190.]

WAC 246-232-011 Exemption of certain self-luminous products containing radioactive material(s). (1) Hydrogen-3 (tritium), krypton-85, or promethium-147.

(a) A person is exempt from the requirements for a license and from this chapter and chapters 246-233 and 246-235 WAC to the extent that the person receives, possesses, uses, transfers, owns or acquires, and does not manufacture, process, produce, apply radioactive material to, incorporate radioactive material into, or initially transfer for sale or distribution, self-luminous products containing hydrogen-3 (tritium), krypton-85, or promethium-147 in self-luminous products manufactured, processed, produced, imported or initially transferred in accordance with a specific license issued by the NRC. The exemption in this subsection does not apply to hydrogen-3, (tritium), krypton-85, or promethium-147 used in products primarily for frivolous purposes or in toys or adornments.

(b) Any person who desires to manufacture, process, produce, or initially transfer for sale or distribution self-luminous products containing tritium (H-3), krypton-85 (Kr-85), or promethium-147 (Pm-147) for use under (a) of this subsection should apply for a license under 10 C.F.R. 32.22 and for a certificate of registration in accordance with WAC 246-235-108.

(2) No person may introduce radioactive material into a product or material knowing, or having reason to believe, that it will be transferred to persons exempt under this section or other sections or

equivalent regulations of the NRC or an agreement state, except in accordance with a specific license issued by the NRC, Washington, D.C. 20555.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-232-011, filed 12/12/16, effective 1/12/17; WSR 16-13-054, § 246-232-011, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-011, filed 11/22/13, effective 12/23/13. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 09-06-003, § 246-232-011, filed 2/18/09, effective 3/21/09. Statutory Authority: RCW 70.98.050. WSR 01-02-068, § 246-232-011, filed 12/29/00, effective 1/29/01.]

WAC 246-232-012 Exemption of certain gas and aerosol detectors containing radioactive material. (1)(a) Except for persons who manufacture, process, produce, or initially transfer for sale or distribution gas and aerosol detectors containing radioactive material, any person is exempt from the requirements for a license and from this chapter and chapters 246-221, 246-222, 246-233, 246-235, 246-240, 246-243, and 246-244 WAC to the extent that the person receives, possesses, uses, transfers, owns or acquires radioactive material in gas and aerosol detectors designed to protect health, safety, or property, and

manufactured, processed, produced, or initially transferred in accordance with a specific license issued under 10 C.F.R. 32.26 which authorizes the initial transfer of the product for use under this chapter. This exemption also covers gas and aerosol detectors manufactured or distributed before November 30, 2007, in accordance with a specific license issued by a state under provisions comparable to 10 C.F.R. 32.26 authorizing distribution to persons exempt from regulatory requirements.

(b) Any person who desires to manufacture, process, or produce gas and aerosol detectors containing radioactive material, or to initially transfer such products for use under this subsection should apply for a license under 10 C.F.R. 32.26 and for a certificate of registration in accordance with WAC 246-235-108.

(2) No person may introduce radioactive material into a product or material knowing, or having reason to believe, that it will be transferred to persons exempt under this section or other sections or equivalent regulations of the NRC or an agreement state, except in accordance with a specific license issued by the NRC, Washington, D.C. 20555.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-232-012, filed 12/12/16, effective 1/12/17; WSR 16-13-054, § 246-

232-012, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-012, filed 11/22/13, effective 12/23/13; WSR 01-02-068, § 246-232-012, filed 12/29/00, effective 1/29/01.]

WAC 246-232-014 Exemption of C-14 urea diagnostic capsules for human use. (1) Except as provided in subsections (2) and (3) of this section, a person is exempt from the requirements for a license and from this chapter and chapters 246-233 and 246-235 WAC if the person receives, possesses, uses, transfers, owns, or acquires, and does not apply radioactive material to, or incorporate radioactive material into, capsules containing 37 kilobecquerels (1 microcurie) of carbon-14 urea (allowing for nominal variation that may occur during the manufacturing process) each, for "in-vivo" diagnostic use for humans.

(2) A person who desires to use the capsules for research involving human subjects must apply for and receive a specific license under chapters 246-240 and 246-235 WAC.

(3) A person who desires to manufacture, prepare, process, produce, package, repackage, or transfer for commercial distribution these capsules must do so in accordance with a specific license issued by the NRC, Washington, D.C. 20555.

(4) Nothing in this section relieves persons from complying with applicable United States Food and Drug Administration, federal, and state requirements governing receipt, administration, and use of drugs.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-232-014, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-014, filed 11/22/13, effective 12/23/13; WSR 06-05-019, § 246-232-014, filed 2/6/06, effective 3/9/06; WSR 01-02-068, § 246-232-014, filed 12/29/00, effective 1/29/01.]

WAC 246-232-015 Certain industrial devices. (1) Except for persons who manufacture, process, produce, or initially transfer for sale or distribution industrial devices containing radioactive material designed and manufactured for the purpose of detecting, measuring, gauging or controlling thickness, density, level, interface location, radiation, leakage, or qualitative or quantitative chemical composition, or for producing an ionized atmosphere, any person is exempt from the requirements for a license and from the regulations in chapters 246-222, 246-221, 246-232, 246-233, 246-235, 246-243, 246-240, and 246-244 WAC to the extent that such person receives, possesses, uses, trans-

fers, owns, or acquires radioactive material, in these certain detecting, measuring, gauging, or controlling devices and certain devices for producing an ionized atmosphere, and manufactured, processed, produced, or initially transferred in accordance with a specific license issued under 10 C.F.R. 32.30 which authorizes the initial transfer of the device for use under this section. This exemption does not cover sources not incorporated into a device, such as calibration and reference sources.

(2) Any person who desires to manufacture, process, produce, or initially transfer for sale or distribution industrial devices containing radioactive material for use under subsection (1) of this section, should apply for a license under 10 C.F.R. 32.30 and for a certificate of registration in accordance with WAC 246-235-108.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-232-015, filed 12/12/16, effective 1/12/17; WSR 16-13-054, § 246-232-015, filed 6/10/16, effective 7/11/16.]

WAC 246-232-020 Types of licenses. Licenses for radioactive material are of two types: General and specific.

(1) A general license is provided by regulation and grants authority to a person for certain activities involving radioactive mate-

rial, and is effective without filing an application with the department or issuance of licensing documents to a particular person. However, registration or the filing of a certificate with the department may also be required by the particular general license. The general licensee is subject to all other applicable rules and any limitations of the general license.

(2) The department issues a specific license to a named person, after review and approval of an application. The licensee is subject to all applicable rules, including chapter 246-235 WAC, Radioactive materials - Specific licenses, and any limitations specified in the specific license.

[Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-020, filed 11/22/13, effective 12/23/13; WSR 04-04-055, § 246-232-020, filed 1/30/04, effective 3/1/04. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-232-020, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-020, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 79-12-073 (Order 1459), § 402-19-220, filed 11/30/79, effective 1/1/80. Formerly WAC 402-20-020.]

WAC 246-232-030 Prelicensing inspection. The department may verify information contained in applications and secure additional information deemed necessary to make a reasonable determination as to whether to issue a license and whether any special conditions should be attached thereto by visiting the facility or location where radioactive materials would be possessed or used, and by discussing details of the proposed possession or use of the radioactive materials with the applicant or representatives designated by the applicant. Such visits may be made by the department or its duly authorized representatives.

[Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-030, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 79-12-073 (Order 1459), § 402-19-240, filed 11/30/79, effective 1/1/80. Formerly WAC 402-20-200.]

WAC 246-232-040 Reciprocal recognition of licenses. Before radioactive material can be used at any temporary job site, the jurisdictional status of the job site must be determined. Authorization for use of radioactive material at job sites under exclusive federal jurisdiction must be obtained from the appropriate regional office of the NRC, Washington, D.C. 20555. Before radioactive materials can be

used as a temporary job site in another state, authorization must be obtained from that state if it is an agreement state, or from the NRC if it is a nonagreement state.

(1) A person authorized by a license issued by the NRC or an agreement state, may obtain authorization from the department to work in Washington state provided:

(a) The out-of-state license is issued by the NRC or agreement state with jurisdiction where the licensee maintains an office for directing the licensed work and for retaining radiation safety records;

(b) The out-of-state licensee must not possess or use radioactive materials or conduct authorized work in Washington state for more than one hundred eighty days in that twelve month period which starts the date approval is granted, and the appropriate fee is received by the department, as required in chapter 246-254 WAC;

(c) The out-of-state licensing document authorizes the work conducted;

(d) The licensed work is not conducted in an area under exclusive federal jurisdiction;

(e) The appropriate fee is currently paid, as required in chapter 246-254 WAC. Licensees send fees to Washington State Department of

Health, Revenue Accounting, P.O. Box 1099, Olympia, Washington 98504-1099;

(f) The out-of-state licensee notifies the department in writing at least three days before each entry into Washington state to conduct licensed work.

(i) The written notification must be sent to the Radioactive Materials Section, Department of Health, P.O. Box 47827, Olympia, Washington 98504-7827. Fax, email, or other notifications may be approved by the department.

(ii) The written notification must include use and storage location(s), start and end dates of licensed work, and type of proposed possession and use in Washington state, and must include licensing documents authorizing the licensed work.

(iii) If an unexpected need or emergency means the three-day notice is impossible or would impose an undue hardship on the out-of-state licensee, the out-of-state licensee may telephone the department (360-236-3221), for permission to proceed immediately.

(iv) The department may waive the requirement for filing additional written notifications during the remainder of the twelve months following the receipt of the initial notification.

(g) The out-of-state licensee must:

(i) Comply with all terms and conditions of the licensing document issued by the licensing authority except such terms or conditions contrary to the requirements or rules of the department or this section;

(ii) Comply with all applicable rules, terms and conditions of the department; and

(iii) Promptly provide other information the department may request.

(h) The out-of-state licensee must request approval for changes in work locations, radioactive material, or work conducted if different from the most recent information provided to the department.

(i) The out-of-state licensee may not transfer or dispose of radioactive material except by transfer to a person specifically licensed by the department or by the NRC or an agreement state to receive such material.

(j) The out-of-state specific licensee may possess or use radioactive material or conduct authorized work in offshore waters for more than one hundred eighty days in any calendar year, if the specific license issued by an agreement state or the NRC authorizes the specific licensee to possess or use radioactive material or conduct authorized work in offshore waters for an unlimited period of time.

(2) A person who holds a specific license issued by the NRC or an agreement state authorizing the holder to manufacture, install, or service a device described in WAC 246-233-020 within the areas subject to the jurisdiction of the licensing body is hereby granted a general license to install and service such device in this state in areas not under exclusive federal jurisdiction provided:

(a) Such person must file a report with the department within thirty days after the end of each calendar quarter in which any device is transferred to or from, or installed in this state. Each report must identify each general licensee to or from whom such device is transferred by name and address, the device manufacturer (or initial transferor), model number and serial number, and the quantity and type of radioactive material contained in the device;

(b) The device has been, and is, manufactured, labeled, installed, and serviced in accordance with applicable provisions of the specific license issued to a person by the NRC or an agreement state;

(c) Such person must ensure that any labels required to be affixed to the device under rules of the authority which licensed the manufacture of the device bear a statement that removal of the label is prohibited; and

(d) The specific licensee must provide each general licensee to and from whom such device is transferred, or on whose premises such device is installed, a copy of the general license in WAC 246-233-020.

(3) The department 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 to prevent undue hazard to public health and safety, or to the environment, or to property.

[Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-040, filed 11/22/13, effective 12/23/13; WSR 04-04-055, § 246-232-040, filed 1/30/04, effective 3/1/04; WSR 01-02-068, § 246-232-040, filed 12/29/00, effective 1/29/01; WSR 99-15-105, § 246-232-040, filed 7/21/99, effective 8/21/99; WSR 98-13-037, § 246-232-040, filed 6/8/98, effective 7/9/98. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-232-040, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-040, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-19-250, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-19-250, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-

01-011 (Order 1570), § 402-19-250, filed 12/8/80. Statutory Authority:
RCW 70.98.080. WSR 79-12-073 (Order 1459), § 402-19-250, filed
11/30/79, effective 1/1/80. Formerly WAC 402-20-210.]

WAC 246-232-050 Terms and conditions of licenses. (1) Each li-
cense issued pursuant to this part shall be subject to all the provi-
sions of the act, as now or hereafter in effect, and to all rules,
regulations, and orders of the department.

(2) No license issued or granted under chapters 246-232, 246-233,
or 246-235 WAC and no right to possess or use radioactive material
granted by any license issued pursuant to chapters 246-233 and 246-235
WAC shall be transferred, assigned, or in any manner disposed, either
voluntarily or involuntarily, directly or indirectly, through transfer
of control of any license to any person unless the department shall,
after securing full information, find that the transfer is in accord-
ance with the provisions of the act, and gives its consent in writing.

(3) Each person licensed by the department pursuant to chapters
246-233 and 246-235 WAC shall confine use and possession of the mate-
rial licensed to the locations and purposes authorized by the license.

(4) Approval of licensee's procedures by the department does not
release the licensee from responsibility if adherence to these proce-

dures results in undue exposure to individuals or loss of control of radioactive material.

(5) Each specific licensee must notify the department of health, office of radiation protection, 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:

(a) The licensee;

(b) An entity (as the term is defined in 11 U.S.C. 101(15)) controlling the licensee or listing the license or licensee as property of the estate; or

(c) An affiliate (as the term is defined in 11 U.S.C. 101(2)) of the licensee.

(6) The specific licensee's bankruptcy notification must include:

(a) The bankruptcy court in which the petition for bankruptcy was filed;

(b) The date of the filing of the petition;

(c) A complete and detailed inventory of all radioactive material possessed under the license including nuclide, form, activity and planned disposition;

(d) An estimation of the type and quantities of radioactive material the licensee plans to continue to receive or use on a routine basis;

(e) A description of security and storage for the radioactive material currently possessed;

(f) A plan for radioactive waste disposal, the estimated completion date(s), and the cost;

(g) An evaluation of facility and equipment contamination, estimate of clean-up costs, and a decontamination plan which includes a thorough description of how the cleanup will be funded and how it will be accomplished;

(h) An organizational chart specifying sole owners, partnerships, or officers in the corporation who have legal and fiscal responsibilities for the licensee;

(i) A description of any other changes affecting the terms and conditions of the radioactive materials license.

(7) Each specific licensee must notify the department within five working days if any items in subsection (6) of this section change during bankruptcy proceedings.

(8) The department will consider clean-up costs as part of the licensee's administrative costs if decontamination is necessary to comply with these regulations;

(9) Each general licensee required to register by WAC 246-233-020 (3)(k) must notify the department of health, radiation protection, 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:

(a) The licensee;

(b) An entity (as that term is defined in 11 U.S.C. 101(15)) controlling the licensee or listing the license or licensee as property of the estate; or

(c) An affiliate (as that term is defined in 11 U.S.C. 101(2)) of the licensee.

(10) The general licensee's bankruptcy notification must include:

(a) The bankruptcy court in which the petition for bankruptcy was filed; and

(b) The date of the filing of the petition.

(11) For the purposes of this section, "affiliate" means:

(a) A person as defined in WAC 246-220-010 that directly or indirectly owns, controls, or holds with power to vote, twenty percent or

more of the outstanding voting securities of the licensee (unless that person holds such securities (i) in a fiduciary or agency capacity without sole discretionary power to vote such securities, or (ii) solely to secure a debt, if such person has not in fact exercised such power to vote);

(b) A corporation, twenty percent or more of whose outstanding voting securities are directly or indirectly owned, controlled, or held with power to vote, by the licensee;

(c) A person whose business is operated under a lease or operating agreement by a licensee, or person substantially all of whose property is operated under an operating agreement with the licensee;
or

(d) A person that operates the business or substantially all of the property of the licensee under a lease or operating agreement.

[Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-050, filed 11/22/13, effective 12/23/13; WSR 04-04-055, § 246-232-050, filed 1/30/04, effective 3/1/04. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 92-06-008 (Order 245), § 246-232-050, filed 2/21/92, effective 3/23/92. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-050, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031

(Order 2450), § 402-19-300, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-19-300, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-19-300, filed 12/8/80. Statutory Authority: RCW 70.98.080. WSR 79-12-073 (Order 1459), § 402-19-300, filed 11/30/79, effective 1/1/80.]

WAC 246-232-060 Termination of licenses and decommissioning of sites and separate buildings or outdoor areas. (1) Each specific licensee shall immediately notify the department in writing when the licensee decides to permanently discontinue all activities involving materials authorized under the license and request termination of the license. This notification and request for termination of the license must include the reports and information specified in subsection (3)(c) and (d) of this section. The licensee is subject to the provisions of subsections (3) and (4) of this section, as applicable.

(2) No less than thirty days before the expiration date specified in a specific license, the licensee shall either:

(a) Submit an application for license renewal under WAC 246-235-050; or

(b) Notify the department in writing if the licensee decides not to renew the license.

(3) If a specific licensee does not submit an application for license renewal under WAC 246-235-050, the licensee shall on or before the expiration date specified in the license:

(a) Terminate use of radioactive material;

(b) Properly dispose of radioactive material;

(c) Submit a completed departmental form "Certificate of disposition of radioactive material" or equivalent; and

(d) Submit a radiation survey report to confirm the absence of radioactive materials or establish the levels of radioactive contamination, unless the department determines a radiation survey report is not necessary.

(i) If no radioactive contamination attributable to activities conducted under the license is detected, the licensee shall submit a certification that no detectable radioactive contamination was found. If the information submitted under this paragraph and subsection (3)(c) and (d) of this section is adequate, the department will notify the licensee in writing that the license is terminated.

(ii) If detectable levels of radioactive contamination attributable to activities conducted under the license are found, the license continues in effect beyond the expiration date, if necessary, with respect to possession of residual radioactive material present as con-

tamination until the licensee meets the criteria established in chapter 246-246 WAC and the department notifies the licensee in writing that the license is terminated. During this time, the licensee is subject to the provisions of subsection (4) of this section. In addition to the information submitted under subsection (3)(c) and (d) of this section, the licensee shall submit a plan for decontamination, if necessary.

(4) Each specific licensee who possesses residual radioactive material under subsection (3)(d)(ii) of this section, following the expiration of the license, shall:

(a) Be limited to actions, involving radioactive material related to decontamination and preparation for release in accordance with chapter 246-246 WAC; and

(b) Continue to control entry to restricted areas until:

(i) Such areas are suitable for release in accordance with chapter 246-246 WAC;

(ii) Contaminated equipment complies with guidance contained in WAC 246-232-140, Schedule D; and

(iii) The department notifies the licensee in writing that the license is terminated.

(5) Each general licensee licensed under the provisions of WAC 246-233-040, shall immediately notify the department in writing when the licensee decides to discontinue all activities involving radioactive materials authorized under the general license. Such notification shall include a description of how the generally licensed material was disposed and the results of facility surveys, if applicable, to confirm the absence of radioactive materials.

(6) Within sixty days of the occurrence of any of the following, each specific licensee shall provide notification to the department in writing of such occurrence, and either begin decommissioning its site, or any separate building or outdoor area that contains residual radioactivity so that the site, building, or outdoor area is suitable for release in accordance with chapter 246-246 WAC, or submit within twelve months of notification a decommissioning plan, if required by subsection (10)(a) of this section, and begin decommissioning upon approval of that plan if:

(a) The license has expired or has been revoked by the department; or

(b) The licensee has decided to permanently cease principal activities, as defined in this section, at the entire site or in any separate building or outdoor area that contains residual radioactivity

such that the site, building, or outdoor area is unsuitable for release in accordance with chapter 246-246 WAC; or

(c) No principal activities under the license have been conducted for a period of twenty-four months; or

(d) No principal activities have been conducted for a period of twenty-four months in any separate building or outdoor area that contains residual radioactivity such that the building or outdoor area is unsuitable for release in accordance with chapter 246-246 WAC.

(7) As used in this section, 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 licensed material is accessed for use or disposal and activities incidental to decontamination or decommissioning are not principal activities.

(8) Coincident with the notification required by subsection (6) of this section, the licensee shall maintain in effect all decommissioning financial assurances established by the licensee pursuant to WAC 246-235-075 or as required by this section. The amount of the financial assurance must be increased, or may be decreased, as appropriate, to cover the detailed cost estimate for decommissioning established pursuant to subsection (10)(d)(v) of this section. Following

approval of the decommissioning plan, a licensee may reduce the amount of the financial assurance as decommissioning proceeds and radiological contamination is reduced at the site with the approval of the department.

(9) The department may grant a request to extend the time periods established in subsection (6) of this section if the department determines that this relief is not detrimental to the public health and safety and is otherwise in the public interest. The request must be submitted no later than thirty days before notification pursuant to subsection (6) of this section. The schedule for decommissioning set forth in subsection (6) of this section may not commence until the department has made a determination on the request.

(10)(a) A decommissioning plan must be submitted if required by license condition or if the procedures and activities necessary to carry out decommissioning of the site or separate building or outdoor area have not been previously approved by the department and these procedures could increase potential health and safety impacts to workers or to the public, such as in any of the following cases:

(i) Procedures would involve techniques not applied routinely during cleanup or maintenance operations;

(ii) Workers would be entering areas not normally occupied where surface contamination and radiation levels are significantly higher than routinely encountered during operation;

(iii) Procedures could result in significantly greater airborne concentrations of radioactive materials than are present during operation; or

(iv) Procedures could result in significantly greater releases of radioactive material to the environment than those associated with operation.

(b) The department may approve an alternate schedule for submittal of a decommissioning plan required pursuant to subsection (6) of this section if the department determines that the alternative schedule is necessary to the effective conduct of decommissioning operations and presents no undue risk from radiation to the public health and safety and is otherwise in the public interest.

(c) Procedures such as those listed in (a) of this subsection with potential health and safety impacts may not be carried out prior to approval of the decommissioning plan.

(d) The proposed decommissioning plan for the site or separate building or outdoor area must include:

(i) A description of the conditions of the site or separate building or outdoor area sufficient to evaluate the acceptability of the plan;

(ii) A description of planned decommissioning activities;

(iii) A description of methods used to ensure protection of workers and the environment against radiation hazards during decommissioning;

(iv) A description of the planned final radiation survey;

(v) An updated detailed cost estimate for decommissioning, comparison of that estimate with present funds set aside for decommissioning, and a plan for assuring the availability of adequate funds for completion of decommissioning;

(vi) A description of the physical security plan and material control and accounting plan provisions in place during decommissioning;

(vii) For decommissioning plans calling for completion of decommissioning later than twenty-four months after plan approval, the plan shall include a justification for the delay based on the criteria in subsection (12) of this section.

(e) The proposed decommissioning plan will be approved by the department if the information therein demonstrates that the decommissioning

sioning will be completed as soon as practicable and that the health and safety of workers and the public will be adequately protected.

(11)(a) Except as provided in subsection (12) of this section, licensees shall complete decommissioning of the site or separate building or outdoor area as soon as practicable but no later than twenty-four months following the initiation of decommissioning.

(b) Except as provided in subsection (12) of this section, when decommissioning involves the entire site, the licensee shall request license termination as soon as practicable but no later than twenty-four months following the initiation of decommissioning.

(12) The department may approve a request for an alternative schedule for completion of decommissioning of the site or separate building or outdoor area, and license termination if appropriate, if the department determines that the alternative is warranted by consideration of the following:

(a) Whether it is technically feasible to complete decommissioning within the allotted twenty-four-month period;

(b) Whether sufficient waste disposal capacity is available to allow completion of decommissioning within the allotted twenty-four-month period;

(c) Whether a significant volume reduction in wastes requiring disposal will be achieved by allowing short-lived radionuclides to decay;

(d) Whether a significant reduction in radiation exposure to workers can be achieved by allowing short-lived radionuclides to decay; and

(e) Other site-specific factors which the department may consider appropriate on a case-by-case basis, such as the regulatory requirements of other government agencies, lawsuits, groundwater treatment activities, monitored natural groundwater restoration, actions that could result in more environmental harm than deferred cleanup, and other factors beyond the control of the licensee.

(13) As the final step in decommissioning, the licensee shall:

(a) Certify the disposition of all licensed material, including accumulated wastes, by submitting a completed certificate of disposition of radioactive material or equivalent information; and

(b) Conduct a radiation survey of the premises where the licensed activities were carried out and submit a report of the results of this survey, unless the licensee demonstrates in some other manner that the premises are suitable for release in accordance with the criteria for

decommissioning in chapter 246-246 WAC. The licensee shall, as appropriate:

(i) Report levels of gamma radiation in units of millisieverts (microroentgen) per hour at one meter from surfaces, and report levels of radioactivity, including alpha and beta, in units of megabecquerels (disintegrations per minute or microcuries) per one hundred square centimeters—removable and fixed—for surfaces, megabecquerels (microcuries) per milliliter for water, and becquerels (picocuries) per gram for solids such as soils or concrete; and

(ii) Specify the survey instrument(s) used and certify that each instrument is properly calibrated and tested.

(14) Specific licenses, including expired licenses, will be terminated by written notice to the licensee when the department determines that:

(a) Radioactive material has been properly disposed;

(b) Reasonable effort has been made to eliminate residual radioactive contamination, if present; and

(c)(i) A radiation survey has been performed which demonstrates that the premises are suitable for release in accordance with the criteria for decommissioning in chapter 246-246 WAC; or

(ii) Other information submitted by the licensee is sufficient to demonstrate that the premises are suitable for release in accordance with the criteria for decommissioning in chapter 246-246 WAC; and

(d) Records required by subsections (16) and (18) of this section have been received.

(15) Specific licenses for uranium and thorium milling are exempt from subsections (6)(d), (9) and (10) of this section with respect to reclamation of tailings impoundments or waste disposal areas.

(16) Prior to license termination, each licensee authorized to possess radioactive material with a half-life greater than one hundred twenty days, in an unsealed form, shall forward the following records to the department:

(a) Records of disposal required by WAC 246-221-230 (8)(a); and

(b) Records of results required by WAC 246-221-230 (7)(h).

(17) If licensed activities are transferred or assigned in accordance with WAC 246-232-050(2), each licensee authorized to possess radioactive material, with a half-life greater than one hundred twenty 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:

(a) Records of disposal required by WAC 246-221-230 (8)(a); and

(b) Records of results required by WAC 246-221-230 (7)(h).

(18) Prior to license termination, each licensee shall forward the records required by WAC 246-235-075(6) to the department.

[Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-060, filed 11/22/13, effective 12/23/13; WSR 04-04-055, § 246-232-060, filed 1/30/04, effective 3/1/04; WSR 00-07-085, § 246-232-060, filed 3/15/00, effective 4/15/00; WSR 99-15-105, § 246-232-060, filed 7/21/99, effective 8/21/99. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 97-08-095, § 246-232-060, filed 4/2/97, effective 5/3/97; WSR 91-15-112 (Order 184), § 246-232-060, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-060, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-19-330, filed 9/16/83.]

WAC 246-232-070 Modification and revocation of licenses. (1) The terms and conditions of all licenses shall be subject to amendment, revision, or modification, or the license may be suspended or revoked by reason of amendments to the act, or by reason of rules, regulations, and orders issued by the department.

(2) Any license may be revoked, suspended, or modified, in whole or in part, for any material false statement in the application or any statement of fact required under provisions of the act, or because of conditions revealed by such application or statement of fact or any report, record, or inspection or other means which would warrant the department to refuse to grant a license on an original application, or for violation of, or failure to observe any of the terms and conditions of the act, or of the license, or of any rule, regulation, or order of the department.

(3) Except in cases of willful disregard for the regulations or applicable license conditions or those in which the public health, interest, or safety requires otherwise, no license shall be modified, suspended, or revoked unless, prior to the institution of proceedings therefore, facts or conduct which may warrant such action shall have been called to the attention of the licensee in writing and the licensee shall have been accorded an opportunity to demonstrate or achieve compliance with all lawful requirements.

[Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-070, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-19-350, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-19-350, filed

9/16/83; WSR 79-12-073 (Order 1459), § 402-19-350, filed 11/30/79, effective 1/1/80. Formerly WAC 402-20-180.]

WAC 246-232-080 Transfer of material. (1) No licensee shall transfer radioactive material except as authorized pursuant to this section.

(2) Except as otherwise provided in the license and subject to the provisions of this section, a licensee may transfer radioactive material:

(a) To the department. A licensee may transfer material to the department only after receiving prior approval from the department;

(b) To the United States Department of Energy;

(c) To a person exempt from the rules in this part to the extent permitted under such exemption;

(d) To a person authorized to receive such material under terms of a general license or its equivalent, or a specific license or equivalent licensing document, issued by the department, the NRC or an agreement state, or to a person otherwise authorized to receive such material by the federal government or an agency thereof, the department, or an agreement state; or

(e) As otherwise authorized by the department in writing.

(3) Before transferring radioactive material to a specific licensee of the department, the NRC or an agreement state, or to a general licensee who is required to register with the department, the NRC or an agreement state prior to receipt of the radioactive material, the licensee transferring the material must verify that the transferee's license authorizes the receipt of the type, form, and quantity of radioactive material to be transferred.

(4) The following methods for the verification required by subsection (3) of this section are acceptable:

(a) The transferor may obtain for possession, and read, a current copy of the transferee's specific license or registration certificate;

(b) The transferor may obtain for possession a written certification from the transferee that the transferee is authorized by license or registration certificate to receive the type, form, and quantity of radioactive material to be transferred, specifying the license or registration certificate number, issuing agency, and expiration date;

(c) For emergency shipments the transferor may accept oral certification by the transferee that the transferee is authorized by license or registration certificate to receive the type, form, and quantity of radioactive material to be transferred, specifying the license or registration certificate number, issuing agency, and expiration

date: Provided, That the oral certification is confirmed in writing within ten days;

(d) The transferor may obtain other sources of information compiled by a reporting service from official records of the department, the NRC or the licensing agency of an agreement state as to the identity of licensees and the scope and expiration dates of licenses and registration; or

(e) When none of the methods of verification described in subsection (4) of this section are readily available or when a transferor desires to verify that information received by one of such methods is correct or up-to-date, the transferor may obtain and record confirmation from the department, the NRC or the licensing agency of an agreement state that the transferee is licensed to receive the radioactive material.

(5) Preparation for shipment and transport of radioactive material must be in accordance with the provisions of WAC 246-232-090.

(6) The requirements of subsection (4) of this section notwithstanding, no verification is required when returning used, unused or decayed sources of radiation to the original manufacturer, (e.g., industrial radiography sources, high dose-rate afterloader sources, tel-

etherapy sources, portable moisture/density gauge sources, fixed gauge sources, and Mo-99/Tc-99m or Rb-82/Sr-82 generators).

[Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-080, filed 11/22/13, effective 12/23/13. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-232-080, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-080, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-19-400, filed 12/11/86. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-19-400, filed 12/8/80. Statutory Authority: RCW 70.98.080. WSR 79-12-073 (Order 1459), § 402-19-400, filed 11/30/79, effective 1/1/80. Formerly WAC 402-20-170.]

WAC 246-232-090 Transportation. No person shall deliver radioactive material to a carrier for transport or transport radioactive material except as authorized in a general or specific license issued by the department or as exempted in chapter 246-231 WAC. General licenses for transportation of radioactive material and other transportation requirements are found in chapter 246-231 WAC.

[Statutory Authority: RCW 70.98.050. WSR 99-15-105, § 246-232-090, filed 7/21/99, effective 8/21/99. Statutory Authority: RCW 70.98.050

and 70.98.080. WSR 91-15-112 (Order 184), § 246-232-090, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-090, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-19-500, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-19-500, filed 12/8/80. Statutory Authority: RCW 70.98.080. WSR 79-12-073 (Order 1459), § 402-19-500, filed 11/30/79, effective 1/1/80. Formerly WAC 402-20-220.]

WAC 246-232-120 Schedule B, exempt quantities of radioactive materials. (See also WAC 246-232-010(2).)

Radioactive Material	Microcuries
Antimony-122 (Sb-122)	100
Antimony-124 (Sb-124)	10
Antimony-125 (Sb-125)	10
Arsenic-73 (As-73)	100
Arsenic-74 (As-74)	10
Arsenic-76 (As-76)	10
Arsenic-77 (As-77)	100
Barium-131 (Ba-131)	10
Barium-133 (Ba-133)	10
Barium-140 (Ba-140)	10
Bismuth-210 (Bi-210)	1
Bromine-82 (Br-82)	10
Cadmium-109 (Cd-109)	10
Cadmium-115m (Cd-115m)	10
Cadmium-115 (Cd-115)	100
Calcium-45 (Ca-45)	10
Calcium-47 (Ca-47)	10
Carbon-14 (C-14)	100
Cerium-141 (Ce-141)	100
Cerium-143 (Ce-143)	100
Cerium-144 (Ce-144)	1
Cesium-129 (Cs-129)	100
Cesium-131 (Cs-131)	1,000

Radioactive Material	Microcuries
Cesium-134m (Cs-134m)	100
Cesium-134 (Cs-134)	1
Cesium-135 (Cs-135)	10
Cesium-136 (Cs-136)	10
Cesium-137 (Cs-137)	10
Chlorine-36 (Cl-36)	10
Chlorine-38 (Cl-38)	10
Chromium-51 (Cr-51)	1,000
Cobalt-57 (Co-57)	100
Cobalt-58m (Co-58m)	10
Cobalt-58 (Co-58)	10
Cobalt-60 (Co-60)	1
Copper-64 (Cu-64)	100
Dysprosium-165 (Dy-165)	10
Dysprosium-166 (Dy-166)	100
Erbium-169 (Er-169)	100
Erbium-171 (Er-171)	100
Europium-152 (Eu-152) 9.2h	100
Europium-152 (Eu-152) 13 yr	1
Europium-154 (Eu-154)	1
Europium-155 (Eu-155)	10
Fluorine-18 (F-18)	1,000
Gadolinium-153 (Gd-153)	10
Gadolinium-159 (Gd-159)	100
Gallium-67 (Ga-67)	100
Gallium-72 (Ga-72)	10
Germanium-68 (Ge-68)	10
Germanium-71 (Ge-71)	100
Gold-195 (Au-195)	10
Gold-198 (Au-198)	100
Gold-199 (Au-199)	100
Hafnium-181 (Hf-181)	10
Holmium-166 (Ho-166)	100
Hydrogen-3 (H-3)	1,000
Indium-111 (In-111)	100
Indium-113m (In-113m)	100
Indium-114m (In-114m)	10
Indium-115m (In-115m)	100
Indium-115 (In-115)	10
Iodine-123 (I-123)	100
Iodine-125 (I-125)	1
Iodine-126 (I-126)	1
Iodine-129 (I-129)	0.1
Iodine-131 (I-131)	1
Iodine-132 (I-132)	10
Iodine-133 (I-133)	1
Iodine-134 (I-134)	10
Iodine-135 (I-135)	10
Iridium-192 (Ir-192)	10

Radioactive Material	Microcuries
Iridium-194 (Ir-194)	100
Iron-52 (Fe-52)	10
Iron-55 (Fe-55)	100
Iron-59 (Fe-59)	10
Krypton-85 (Kr-85)	100
Krypton-87 (Kr-87)	10
Lanthanum-140 (La-140)	10
Lutetium-177 (Lu-177)	100
Manganese-52 (Mn-52)	10
Manganese-54 (Mn-54)	10
Manganese-56 (Mn-56)	10
Mercury-197m (Hg-197m)	100
Mercury-197 (Hg-197)	100
Mercury-203 (Hg-203)	10
Molybdenum-99 (Mo-99)	100
Neodymium-147 (Nd-147)	100
Neodymium-149 (Nd-149)	100
Nickel-59 (Ni-59)	100
Nickel-63 (Ni-63)	10
Nickel-65 (Ni-65)	100
Niobium-93m (Nb-93m)	10
Niobium-95 (Nb-95)	10
Niobium-97 (Nb-97)	10
Osmium-185 (Os-185)	10
Osmium-191m (Os-191m)	100
Osmium-191 (Os-191)	100
Osmium-193 (Os-193)	100
Palladium-103 (Pd-103)	100
Palladium-109 (Pd-109)	100
Phosphorus-32 (P-32)	10
Platinum-191 (Pt-191)	100
Platinum-193m (Pt-193m)	100
Platinum-193 (Pt-193)	100
Platinum-197m (Pt-197m)	100
Platinum-197 (Pt-197)	100
Polonium-210 (Po-210)	0.1
Potassium-42 (K-42)	10
Potassium-43 (K-43)	10
Praseodymium-142 (Pr-142)	100
Praseodymium-143 (Pr-143)	100
Promethium-147 (Pm-147)	10
Promethium-149 (Pm-149)	10
Radium-226 (Ra-226)	0.1
Rhenium-186 (Re-186)	100
Rhenium-188 (Re-188)	100
Rhodium-103m (Rh-103m)	100
Rhodium-105 (Rh-105)	100
Rubidium-81 (Rb-81)	10
Rubidium-86 (Rb-86)	10

Radioactive Material	Microcuries
Rubidium-87 (Rb-87)	10
Ruthenium-97 (Ru-97)	100
Ruthenium-103 (Ru-103)	10
Ruthenium-105 (Ru-105)	10
Ruthenium-106 (Ru-106)	1
Samarium-151 (Sm-151)	10
Samarium-153 (Sm-153)	100
Scandium-46 (Sc-46)	10
Scandium-47 (Sc-47)	100
Scandium-48 (Sc-48)	10
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

Radioactive Material	Microcuries
Xenon-131m (Xe-131m)	1,000
Xenon-133 (Xe-133)	100
Xenon-135 (Xe-135)	100
Ytterbium-169 (Yb-169)	10
Ytterbium-175 (Yb-175)	100
Yttrium-87 (Y-87)	10
Yttrium-88 (Y-88)	10
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

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-232-120, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 09-06-003, § 246-232-120, filed 2/18/09, effective 3/21/09. Statutory Authority: RCW 70.98.050. WSR 01-02-068, § 246-232-120, filed 12/29/00, effective 1/29/01. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-232-120, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-120, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-19-550, filed 9/16/83; WSR 79-12-073 (Order 1459), § 402-19-550, filed 11/30/79, effective 1/1/80. Formerly WAC 402-20-240.]

WAC 246-232-130 Schedule C, exempt concentrations. (See WAC 246-

232-010(1).)

Element (atomic number)	Radionuclide	Column I Gas concentration $\mu\text{Ci/ml}^1$	Column II Liquid and solid concentration $\mu\text{Ci/ml}^2$
Antimony (51)	Sb-122		3×10^{-4}
	Sb-124		2×10^{-4}
	Sb-125		1×10^{-3}
Argon (18)	Ar-37	1×10^{-3}	
	Ar-41	4×10^{-7}	
Arsenic (33)	As-73		5×10^{-3}
	As-74		5×10^{-4}
	As-76		2×10^{-4}
	As-77		8×10^{-4}
Barium (56)	Ba-131		2×10^{-3}
	Ba-140		3×10^{-4}
Beryllium (4)	Be-7		2×10^{-2}
Bismuth (83)	Bi-206		4×10^{-4}
Bromine (35)	Br-82	4×10^{-7}	3×10^{-3}
Cadmium (48)	Cd-109		2×10^{-3}
	Cd-115m		3×10^{-4}
	Cd-115		3×10^{-4}
Calcium (20)	Ca-45		9×10^{-5}
	Ca-47		5×10^{-4}
Carbon (6)	C-14	1×10^{-6}	8×10^{-3}
Cerium (58)	Ce-141		9×10^{-4}
	Ce-143		4×10^{-4}
	Ce-144		1×10^{-4}
Cesium (55)	Cs-131		2×10^{-2}
	Cs-134m		6×10^{-2}
	Cs-134		9×10^{-5}
Chlorine (17)	Cl-38	9×10^{-7}	4×10^{-3}
Chromium (24)	Cr-51		2×10^{-2}
Cobalt (27)	Co-57		5×10^{-3}
	Co-58		1×10^{-3}
	Co-60		5×10^{-4}
Copper (29)	Cu-64		3×10^{-3}
Dysprosium (66)	Dy-165		4×10^{-3}
	Dy-166		4×10^{-4}
Erbium (68)	Er-169		9×10^{-4}
	Er-171		1×10^{-3}
Europium (63)	Eu-152 (9.2 h)		6×10^{-4}
	Eu-155		2×10^{-3}
Fluorine (9)	F-18	2×10^{-6}	8×10^{-3}
Gadolinium (64)	Gd-153		2×10^{-3}
	Gd-159		8×10^{-4}
Gallium (31)	Ga-72		4×10^{-4}
Germanium (32)	Ge-71		2×10^{-2}
Gold (79)	Au-196		2×10^{-3}
	Au-198		5×10^{-4}
	Au-199		2×10^{-3}
Hafnium (72)	Hf-181		7×10^{-4}
Hydrogen (1)	H-3	5×10^{-6}	3×10^{-2}

Element (atomic number)	Radionuclide	Column I Gas concentration $\mu\text{Ci}/\text{ml}^1$	Column II Liquid and solid concentration $\mu\text{Ci}/\text{ml}^2$
Indium (49)	In-113m		1×10^{-2}
	In-114m		2×10^{-4}
Iodine (53)	I-125	3×10^{-9}	2×10^{-5}
	I-126	3×10^{-9}	2×10^{-5}
	I-131	3×10^{-9}	2×10^{-5}
	I-132	8×10^{-8}	6×10^{-4}
	I-133	1×10^{-8}	7×10^{-5}
	I-134	2×10^{-7}	1×10^{-3}
Iridium (77)	Ir-190		2×10^{-3}
	Ir-192		4×10^{-4}
	Ir-194		3×10^{-4}
Iron (26)	Fe-55		8×10^{-3}
	Fe-59		6×10^{-4}
Krypton (36)	Kr-85m	1×10^{-6}	
	Kr-85		3×10^{-6}
Lanthanum (57)	La-140		2×10^{-4}
Lead (82)	Pb-203		4×10^{-3}
Lutetium (71)	Lu-177		1×10^{-3}
Manganese (25)	Mn-52		3×10^{-4}
	Mn-54		1×10^{-3}
	Mn-56		1×10^{-3}
Mercury (80)	Hg-197m		2×10^{-3}
	Hg-197		3×10^{-3}
	Hg-203		2×10^{-4}
Molybdenum (42)	Mo-99		2×10^{-3}
Neodymium (60)	Nd-147		6×10^{-4}
	Nd-149		3×10^{-3}
Nickel (28)	Ni-65		1×10^{-3}
Niobium (41)	Nb-95		1×10^{-3}
	Nb-97		9×10^{-3}
Osmium (76)	Os-185		7×10^{-4}
	Os-191m		3×10^{-2}
	Os-191		2×10^{-3}
	Os-193		6×10^{-4}
Palladium (46)	Pd-103		3×10^{-3}
	Pd-109		9×10^{-4}
Phosphorus (15)	P-32		2×10^{-4}
Platinum (78)	Pt-191		1×10^{-3}
	Pt-193m		1×10^{-2}
	Pt-197m		1×10^{-2}
	Pt-197		1×10^{-3}
Potassium (19)	K-42		3×10^{-3}
Praseodymium (59)	Pr-142		3×10^{-4}
	Pr-143		5×10^{-4}
Promethium (61)	Pm-147		2×10^{-3}
	Pm-149		4×10^{-4}
Radium (88)	Ra-226		1×10^{-7}
	Ra-228		3×10^{-7}
Rhenium (75)	Re-183		6×10^{-3}
	Re-186		9×10^{-4}
	Re-188		6×10^{-4}
Rhodium (45)	Rh-103m		1×10^{-1}
	Rh-105		1×10^{-3}
Rubidium (37)	Rb-86		7×10^{-4}

Element (atomic number)	Radionuclide	Column I Gas concentration $\mu\text{Ci}/\text{ml}^1$	Column II Liquid and solid concentration $\mu\text{Ci}/\text{ml}^2$
Ruthenium (44)	Ru-97		4×10^{-3}
	Ru-103		8×10^{-4}
	Ru-105		1×10^{-3}
	Ru-106		1×10^{-4}
Samarium (62)	Sm-153		8×10^{-4}
Scandium (21)	Sc-46		4×10^{-4}
	Sc-47		9×10^{-4}
	Sc-48		3×10^{-4}
Selenium (34)	Se-75		3×10^{-3}
Silicon (14)	Si-31		9×10^{-3}
Silver (47)	Ag-105		1×10^{-3}
	Ag-110m		3×10^{-4}
	Ag-111		4×10^{-4}
Sodium (11)	Na-24		2×10^{-3}
Strontium (38)	Sr-85		1×10^{-3}
	Sr-89		1×10^{-4}
	Sr-91		7×10^{-4}
	Sr-92		7×10^{-4}
Sulfur (16)	S-35	9×10^{-8}	6×10^{-4}
Tantalum (73)	Ta-182		4×10^{-4}
Technetium (43)	Tc-96m		1×10^{-1}
	Tc-96		1×10^{-3}
Tellurium (52)	Te-125m		2×10^{-3}
	Te-127m		6×10^{-4}
	Te-127		3×10^{-3}
	Te-129m		3×10^{-4}
	Te-131m		6×10^{-4}
	Te-132		3×10^{-4}
Terbium (65)	Tb-160		4×10^{-4}
Thallium (81)	Tl-200		4×10^{-3}
	Tl-201		3×10^{-3}
	Tl-202		1×10^{-3}
	Tl-204		1×10^{-3}
Thulium (69)	Tm-170		5×10^{-4}
	Tm-171		5×10^{-3}
Tin (50)	Sn-113		9×10^{-4}
	Sn-125		2×10^{-4}
Tungsten (Wolfram) (74)	W-181		4×10^{-3}
	W-187		7×10^{-4}
Vanadium (23)	V-48		3×10^{-4}
Xenon (54)	Xe-131m	4×10^{-6}	
	Xe-133	3×10^{-6}	
	Xe-135	1×10^{-6}	
Ytterbium (70)	Yb-175		1×10^{-3}
Yttrium (39)	Y-90		2×10^{-4}
	Y-91m		3×10^{-2}
	Y-91		3×10^{-4}
	Y-92		6×10^{-4}
	Y-93		3×10^{-4}
Zinc (30)	Zn-65		1×10^{-3}
	Zn-69m		7×10^{-4}
	Zn-69		2×10^{-2}
Zirconium (40)	Zr-95		6×10^{-4}
	Zr-97		2×10^{-4}

Element (atomic number)	Radionuclide	Column I Gas concentration μCi/ml ¹	Column II Liquid and solid concentration μCi/ml ²
Beta or gamma emitting radioactive material not listed above with half-life less than 3 years		1x10 ⁻¹⁰	1x10 ⁻⁶

Notes: ¹ Values are given in Column I only for those materials normally used as gases
² μCi/gm for solids

Note 1: Many radionuclides decay into nuclides which are also radioactive. In expressing the concentrations in Schedule C the activity stated is that of the parent nuclide and takes into account the daughters.

Note 2: For purposes of WAC 246-232-010(1) where there is involved a combination of nuclides, the limit for the combination should be derived as follows: Determine for each nuclide in the product the ratio between the concentration present in the product and the exempt concentration established in Schedule C for the specific nuclide when not in combination. The sum of such ratios may not exceed "1" (i.e., unity).

Example:

$$\frac{\text{Concentration of Nuclide A in Product}}{\text{Exempt concentration of Nuclide A}} + \frac{\text{Concentration of Nuclide B in Product}}{\text{Exempt concentration of Nuclide B}} \leq 1$$

Note 3: For the purpose of determining concentration in a product or device, the total quantity of radioactive material present is divided by only that weight or volume of the discrete part or component throughout which the radioactive material is relatively uniformly distributed. If the weight or volume of this part or component cannot be determined then the product or device should be evaluated on the basis of the total quantity of radioactive material present.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-232-130, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 13-24-025, § 246-232-130, filed 11/22/13, effective 12/23/13; WSR 01-02-068, § 246-232-130, filed 12/29/00, effective 1/29/01. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-232-130, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-130, filed 12/27/90, effective 1/31/91. Statutory

Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-19-580, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-19-580, filed 9/16/83; WSR 79-12-073 (Order 1459), § 402-19-580, filed 11/30/79, effective 1/1/80. Formerly WAC 402-20-250.]

WAC 246-232-140 Schedule D.

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES A	AVERAGE B C F	MAXIMUM B D F	REMOVABLE B E F WIPE LIMITS
U-nat, U-235, U-238, and associated decay products	5,000 dpm/100 cm ²	15,000 dpm/100 cm ²	1,000 dpm α/100 cm ²
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm ²	300 dpm/100 cm ²	20 dpm/100 cm ²
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1000 dpm/100 cm ²	3000 dpm/100 cm ²	200 dpm/100 cm ²
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except SR-90 and others noted above	5000 dpm/100 cm ²	15,000 dpm/100 cm ²	1000 dpm βγ/100 cm ²

- A Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha-and beta-gamma-emitting nuclides should apply independently.
- B As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
- C Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.
- D The maximum contamination level applies to an area of not more than 100 cm².
- E The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.
- F The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

[Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 09-06-003, § 246-232-140, filed 2/18/09, effective 3/21/09. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-140, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080.]

WSR 87-01-031 (Order 2450), § 402-19-590, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-19-590, filed 9/16/83.]

WAC 246-232-990 Fees. Fees are required from all applicants, licensees, or registrants. Chapter 246-254 WAC specifies fees for users of radiation subject to regulation under chapters 246-220 through 246-255 WAC.

[Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-232-990, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-232-990, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-19-370, filed 9/16/83; WSR 79-12-073 (Order 1459), § 402-19-370, filed 11/30/79, effective 1/1/80.]

Chapter 246-237 WAC

RADIATION PROTECTION—PHYSICAL PROTECTION OF CATEGORY 1 AND CATEGORY 2 QUANTITIES OF RADIOACTIVE MATERIAL

Last Update: 12/12/16

WAC

- 246-237-001 Purpose and scope.
- 246-237-010 Definitions, abbreviations, and acronyms.
- 246-237-011 Specific exemptions.
- 246-237-021 Personnel access authorization requirements for Category 1 or Category 2 quantities of radioactive material.
- 246-237-023 Access authorization program requirements.
- 246-237-025 Background investigations.
- 246-237-027 Requirements for criminal history records checks of individuals granted unescorted access to Category 1 or Category 2 quantities of radioactive material.
- 246-237-029 Relief from fingerprinting, identification, and criminal history records checks and other elements of background investigations for designated categories of individuals permitted unescorted access to certain radioactive materials.
- 246-237-031 Protection of information.
- 246-237-033 Access authorization program review.
- 246-237-041 Security program.

246-237-043 General security program requirements.

246-237-045 LLEA coordination.

246-237-047 Security zones.

246-237-049 Monitoring, detection, and assessment.

246-237-051 Maintenance and testing.

246-237-053 Requirements for mobile devices.

246-237-055 Security program review.

246-237-057 Reporting of events.

246-237-071 Additional requirements for transfer of Category 1 and Category 2 quantities of radioactive material.

246-237-073 Applicability of physical protection of Category 1 and Category 2 quantities of radioactive material during transit.

246-237-075 Preplanning and coordination of shipment of Category 1 or Category 2 quantities of radioactive material.

246-237-077 Advance notification of shipment of Category 1 quantities of radioactive material.

246-237-079 Requirements for physical protection of Category 1 and Category 2 quantities of radioactive material during shipment.

246-237-081 Reporting requirements.

246-237-101 Form of records.

246-237-103 Record retention.

246-237-105 Inspections.

WAC 246-237-001 Purpose and scope. (1) This chapter has been established to provide the requirements for the physical protection program for any licensee that possesses an aggregated Category 1 or Category 2 quantity of radioactive material listed in WAC 246-237-900 Appendix A: Table 1—Category 1 and Category 2. These requirements provide reasonable assurance of the security of Category 1 or Category 2 quantities of radioactive material by protecting these materials from theft or diversion. Specific requirements for access to material, use of material, transfer of material, and transport of material are included. No provision of this chapter authorizes possession of licensed material.

(2) WAC 246-237-021 through 246-237-057 apply to any person who, under the rules in this chapter, possesses or uses at any site an aggregated Category 1 or Category 2 quantity of radioactive material.

(3) WAC 246-237-071 through 246-237-081 apply to any person who, under the rules of this chapter:

(a) Transports or delivers to a carrier for transport in a single shipment, a Category 1 or Category 2 quantity of radioactive material;
or

(b) Imports or exports a Category 1 or Category 2 quantity of radioactive material. The provisions in this chapter apply only to the domestic portion of the transport.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-001, filed 6/14/16, effective 7/15/16.]

WAC 246-237-010 Definitions, abbreviations, and acronyms. The definitions, abbreviations, and acronyms in this section and in WAC 246-220-010 apply throughout this chapter unless the context clearly indicates otherwise:

(1) **"Access control"** means a system for allowing only approved individuals to have unescorted access to the security zone and for ensuring that all other individuals are subject to escorted access.

(2) **"Act"** means the Atomic Energy Act of 1954, including any amendments thereto.

(3) **"Aggregated"** means accessible by the breach of a single physical barrier that would allow access to radioactive material in any form, including any devices that contain the radioactive material, when the total activity equals or exceeds a Category 2 quantity of radioactive material.

(4) **"Agreement state"** means any state with which the Atomic Energy Commission or the NRC has entered into an effective agreement under subsection 274b of the act. Nonagreement state means any other state.

(5) **"Approved individual"** means an individual whom the licensee has determined to be trustworthy and reliable for unescorted access in accordance with WAC 246-237-021 through 246-237-033 and who has completed the training required by WAC 246-237-043(3).

(6) **"Background investigation"** means the investigation conducted by a licensee or applicant to support the determination of trustworthiness and reliability.

(7) **"Becquerel (Bq)"** means the SI unit of activity. One becquerel is equal to 1 disintegration or transformation per second (s^{-1}).

(8) **"By-product material"** means:

(a) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or using special nuclear material;

(b) The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies de-

pleted by these solution extraction operations do not constitute "by-product material" within this definition;

(c)(i) Any discrete source of radium-226 that is produced, extracted, or converted after extraction, before, on, or after August 8, 2005, for use for a commercial, medical, or research activity; or

(ii) Any material that:

(A) Has been made radioactive by use of a particle accelerator;
and

(B) Is produced, extracted, or converted after extraction, before, on, or after August 8, 2005, for use for a commercial, medical, or research activity; and

(d) Any discrete source of naturally occurring radioactive material, other than source material, that:

(i) The NRC, in consultation with the Administrator of the Environmental Protection Agency, the Secretary of Energy, the Secretary of Homeland Security, and the head of any other appropriate federal agency, determines would pose a threat similar to the threat posed by a discrete source of radium-226 to the public health and safety or the common defense and security; and

(ii) Before, on, or after August 8, 2005, is extracted or converted after extraction for use in a commercial, medical, or research activity.

(9) **"Carrier"** means a person engaged in the transportation of passengers or property by land or water as a common, contract, or private carrier, or by civil aircraft.

(10) **"Category 1 quantity of radioactive material"** means a quantity of radioactive material meeting or exceeding the Category 1 threshold in Table 1 of WAC 246-237-900 Appendix A: Table 1—Category 1 and Category 2. This is determined by calculating the ratio of the total activity of each radionuclide to the Category 1 threshold for that radionuclide and adding the ratios together. If the sum equals or exceeds 1, the quantity would be considered a Category 1 quantity. Category 1 quantities of radioactive material do not include the radioactive material contained in any fuel assembly, subassembly, fuel rod, or fuel pellet.

(11) **"Category 2 quantity of radioactive material"** means a quantity of radioactive material meeting or exceeding the Category 2 threshold but less than the Category 1 threshold in Table 1 of WAC 246-237-900 Appendix A: Table 1—Category 1 and Category 2. This is determined by calculating the ratio of the total activity of each ra-

dionuclide to the Category 2 threshold for that radionuclide and adding the ratios together. If the sum equals or exceeds 1, the quantity would be considered a Category 2 quantity. Category 2 quantities of radioactive material do not include the radioactive material contained in any fuel assembly, subassembly, fuel rod, or fuel pellet.

(12) **"Curie"** means a unit of quantity of radioactivity. One curie (Ci) is that quantity of radioactive material which decays at the rate of 3.7×10^{10} transformations per second (tps).

(13) **"Diversion"** means the unauthorized movement of radioactive material subject to this chapter to a location different from the material's authorized destination inside or outside of the site at which the material is used or stored.

(14) **"Escorted access"** means accompaniment while in a security zone by an approved individual who maintains continuous direct visual surveillance at all times over an individual who is not approved for unescorted access.

(15) **"FBI"** means the federal bureau of investigation.

(16) **"Fingerprint orders"** means the orders issued by the NRC or the legally binding requirements issued by agreement states that require fingerprints and criminal history records checks for individuals

with unescorted access to Category 1 and Category 2 quantities of radioactive material or safeguards information-modified handling.

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

(18) **"License"** means, except where otherwise specified, a license for radioactive material issued pursuant to the regulations in chapters 246-232, 246-233, 246-235, 246-240, 246-243, or 246-244 WAC.

(19) **"License issuing authority"** means the licensing agency (the department, NRC, or an agreement state) that issued the license.

(20) **"LLEA (local law enforcement agency)"** means a public or private organization that has been approved by a federal, state, or local government to carry firearms and make arrests, and is authorized and has the capability to provide an armed response in the jurisdiction where the licensed Category 1 or Category 2 quantity of radioactive material is used, stored, or transported.

(21) **"Lost or missing licensed material"** means licensed material whose location is unknown. It includes material that has been shipped

but has not reached its destination and whose location cannot be readily traced in the transportation system.

(22) **"Mobile device"** means a piece of equipment containing licensed radioactive material that is either mounted on wheels or casters, or otherwise equipped for moving without a need for disassembly or dismounting; or designed to be hand carried. Mobile devices do not include stationary equipment installed in a fixed location.

(23) **"Movement control center"** means an operations center that is remote from transport activity and that maintains position information on the movement of radioactive material, receives reports of attempted attacks or thefts, provides a means for reporting these and other problems to appropriate agencies, and can request and coordinate appropriate aid.

(24) **"No-later-than arrival time"** means the date and time that the shipping licensee and receiving licensee have established as the time at which an investigation will be initiated if the shipment has not arrived at the receiving facility. The no-later-than arrival time may not be more than six hours after the estimated arrival time for shipments of Category 2 quantities of radioactive material.

(25) **"NRC"** means the U.S. Nuclear Regulatory Commission.

(26) **"Person"** means any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, government agency other than NRC or the Department of Energy, any state or any political subdivision of, or any political entity within, a state, any foreign government or nation, or any political subdivision of any such government or nation, or other entity, and any legal successor, representative, agent or agency of the foregoing.

(27) **"Reviewing official"** means the individual who makes the trustworthiness and reliability determination of an individual to determine whether the individual may have, or continue to have, unescorted access to the Category 1 or Category 2 quantities of radioactive materials that are possessed by the licensee.

(28) **"Sabotage"** means deliberate damage, with malevolent intent, to a Category 1 or Category 2 quantity of radioactive material, a device that contains a Category 1 or Category 2 quantity of radioactive material, or the components of the security system.

(29) **"Safe haven"** means a readily recognizable and readily accessible site at which security is present or from which, in the event of an emergency, the transport crew can notify and wait for the local law enforcement authorities.

(30) **"Security zone"** means any temporary or permanent area determined and established by the licensee for the physical protection of Category 1 or Category 2 quantities of radioactive material.

(31) **"State"** means a state of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands.

(32) **"Telemetric position monitoring system"** means a data transfer system that captures information by instrumentation or measuring devices about the location and status of a transport vehicle or package between the departure and destination locations.

(33) **"Trustworthiness and reliability"** are characteristics of an individual considered dependable in judgment, character, and performance, such that unescorted access to Category 1 or Category 2 quantities of radioactive material by that individual does not constitute an unreasonable risk to the public health and safety or security. A determination of trustworthiness and reliability for this purpose is based upon the results from a background investigation.

(34) **"Unescorted access"** means solitary access to an aggregated Category 1 or Category 2 quantity of radioactive material or the devices that contain the material.

(35) **"United States"** means when used in a geographical sense includes Puerto Rico and all territories and possessions of the United States.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-010, filed 6/14/16, effective 7/15/16.]

WAC 246-237-011 Specific exemptions. (1) The department may, upon application of any interested person or upon its own initiative, grant such exemptions from the requirements of the rules in this chapter as it determines are authorized by law and will not endanger life or property or the common defense and security, and are otherwise in the public interest.

(2) Any licensee's activities are exempt from the requirements of WAC 246-237-021 through 246-237-057 to the extent that its activities are included in a security plan required by 10 C.F.R. Part 73.

(3) A licensee who possesses radioactive waste that contains Category 1 or Category 2 quantities of radioactive material is exempt from the requirements of WAC 246-237-021 through 246-237-081, except that any radioactive waste that contains discrete sources, ion-exchange resins, or activated material that weighs less than two thousand kg (four thousand four hundred nine pounds) is not exempt from

the requirements of this chapter. The licensee shall implement the following requirements to secure the radioactive waste:

(a) Use continuous physical barriers which allow access to the radioactive waste only through established access control points;

(b) Use a locked door or gate with monitored alarm at the access control point;

(c) Assess and respond to each actual or attempted unauthorized access to determine whether an actual or attempted theft, sabotage, or diversion occurred; and

(d) Immediately notify the LLEA and request an armed response from the LLEA upon determination that there was an actual or attempted theft, sabotage, or diversion of the radioactive waste that contains Category 1 or Category 2 quantities of radioactive material.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-011, filed 6/14/16, effective 7/15/16.]

WAC 246-237-021 Personnel access authorization requirements for Category 1 or Category 2 quantities of radioactive material. (1) General.

(a) Each licensee who possesses an aggregated quantity of radioactive material at or above the Category 2 threshold shall establish,

implement, and maintain its access authorization program in accordance with the requirements of this chapter.

(b) An applicant for a new license and each licensee who would become newly subject to the requirements of this chapter, upon application for modification of its license, shall implement the requirements of this chapter, as appropriate, before taking possession of an aggregated Category 1 or Category 2 quantity of radioactive material.

(c) Any licensee who has not previously implemented the security orders or been subject to the provisions of this chapter shall implement the provisions of this chapter before aggregating radioactive material to a quantity that equals or exceeds the Category 2 threshold.

(2) General performance objective. The licensee's access authorization program must ensure that the individuals specified in subsection (3)(a)(i) and (ii) of this section are trustworthy and reliable.

(3) Applicability.

(a) Licensees shall subject the following individuals to an access authorization program:

(i) Any individual whose assigned duties require unescorted access to Category 1 or Category 2 quantities of radioactive material or to any device that contains the radioactive material; and

(ii) Reviewing officials.

(b) Licensees need not subject the categories of individuals listed in WAC 246-237-029(1) to the investigation elements of the access authorization program.

(c) Licensees shall approve for unescorted access to Category 1 or Category 2 quantities of radioactive material only those individuals with job duties which require unescorted access to Category 1 or Category 2 quantities of radioactive material.

(d) Licensees may include individuals needing access to safeguards information-modified handling under 10 C.F.R. Part 73 in the access authorization program under WAC 246-237-021 through 246-237-033.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-021, filed 6/14/16, effective 7/15/16.]

WAC 246-237-023 Access authorization program requirements. (1)

Granting unescorted access authorization.

(a) Licensees shall implement the requirements of this chapter for granting initial or reinstated unescorted access authorization.

(b) Individuals who have been determined to be trustworthy and reliable shall also complete the security training required by WAC

246-237-043(3) before being allowed unescorted access to Category 1 or Category 2 quantities of radioactive material.

(2) Reviewing officials. Reviewing officials are the only individuals who may make trustworthiness and reliability determinations that allow individuals to have unescorted access to Category 1 or Category 2 quantities of radioactive materials possessed by the licensee.

(a) Each licensee shall name one or more individuals to be reviewing officials. After completing the background investigation on the reviewing official, the licensee shall provide, under oath or affirmation, a certification that the reviewing official is deemed trustworthy and reliable by the licensee. The fingerprints of the named reviewing official must be taken by a law enforcement agency, federal or state agencies that provide fingerprinting services to the public, or commercial fingerprinting services authorized by a state to take fingerprints. The licensee shall recertify that the reviewing official is deemed trustworthy and reliable every ten years in accordance with WAC 246-237-025(3).

(b) Reviewing officials must be permitted to have unescorted access to Category 1 or Category 2 quantities of radioactive materials or access to safeguards information or safeguards information-modified

handling, if the licensee possesses safeguards information or safe-guards information-modified handling.

(c) Reviewing officials cannot approve other individuals to act as reviewing officials.

(d) A reviewing official does not need to undergo a new back-ground investigation before being named by the licensee as the review-ing official if:

(i) The individual has undergone a background investigation that included fingerprinting and an FBI criminal history records check and has been determined to be trustworthy and reliable by the licensee; or

(ii) The individual is subject to a category listed in WAC 246-237-029(1).

(3) Informed consent.

(a) Licensees may not initiate a background investigation without the informed and signed consent of the subject individual. This con-sent must include authorization to share personal information with other individuals or organizations as necessary to complete the back-ground investigation. Before a final adverse determination, the licen-see shall provide the individual with an opportunity to correct any inaccurate or incomplete information that is developed during the background investigation. Licensees do not need to obtain signed con-

sent from those individuals who meet the requirements of WAC 246-237-025(2). A signed consent must be obtained prior to any reinvestigation.

(b) The subject individual may withdraw their consent at any time. Licensees shall inform the individual that:

(i) If an individual withdraws their consent, the licensee may not initiate any elements of the background investigation that were not in progress at the time the individual withdrew their consent; and

(ii) The withdrawal of consent for the background investigation is sufficient cause for denial or termination of unescorted access authorization.

(4) Personal history disclosure. Any individual who is applying for unescorted access authorization shall disclose the personal history information that is required by the licensee's access authorization program for the reviewing official to make a determination of the individual's trustworthiness and reliability. Refusal to provide, or the falsification of, any personal history information required by this chapter is sufficient cause for denial or termination of unescorted access.

(5) Determination basis.

(a) The reviewing official shall determine whether to permit, deny, unfavorably terminate, maintain, or administratively withdraw an individual's unescorted access authorization based on an evaluation of all of the information collected to meet the requirements of this chapter.

(b) The reviewing official may not permit any individual to have unescorted access until the reviewing official has evaluated all of the information collected to meet the requirements of this chapter and determined that the individual is trustworthy and reliable. The reviewing official may deny unescorted access to any individual based on information obtained at any time during the background investigation.

(c) The licensee shall document the basis for concluding whether or not there is reasonable assurance that an individual is trustworthy and reliable.

(d) The reviewing official may terminate or administratively withdraw an individual's unescorted access authorization based on information obtained after the background investigation has been completed and the individual granted unescorted access authorization.

(e) Licensees shall maintain a list of persons currently approved for unescorted access authorization. When a licensee determines that a person no longer requires unescorted access or meets the access au-

thorization requirement, the licensee shall remove the person from the approved list as soon as possible, but no later than seven working days, and take prompt measures to ensure that the individual is unable to have unescorted access to the material.

(6) Procedures. Licensees shall develop, implement, and maintain written procedures for implementing the access authorization program. The procedures must include provisions for the notification of individuals who are denied unescorted access. The procedures must include provisions for the review, at the request of the affected individual, of a denial or termination of unescorted access authorization. The procedures must contain a provision to ensure that the individual is informed of the grounds for the denial or termination of unescorted access authorization and allow the individual an opportunity to provide additional relevant information.

(7) Right to correct and complete information.

(a) Prior to any final adverse determination, licensees shall provide each individual subject to this chapter with the right to complete, correct, and explain information obtained as a result of the licensee's background investigation. Confirmation of receipt by the individual of this notification must be maintained by the licensee for a period of one year from the date of the notification.

(b) If, after reviewing their criminal history record, an individual believes that it is incorrect or incomplete in any respect and wishes to change, correct, update, or explain anything in the record, the individual may initiate challenge procedures. These procedures include direct application by the individual challenging the record to the law enforcement agency that contributed the questioned information or a direct challenge as to the accuracy or completeness of any entry on the criminal history record to the FBI, Criminal Justice Information Services Division, ATTN: SCU, Mod. D-2, 1000 Custer Hollow Road, Clarksburg, WV 26306 as set forth in 28 C.F.R. 16.30 through 16.34. In the latter case, the FBI will forward the challenge to the agency that submitted the data, and will request that the agency verify or correct the challenged entry. Upon receipt of an official communication directly from the agency that contributed the original information, the FBI Identification Division makes any changes necessary in accordance with the information supplied by that agency. Licensees must provide at least ten days for an individual to initiate action to challenge the results of an FBI criminal history records check after the record being made available for their review. The licensee may make a final adverse determination based upon the criminal history records only after receipt of the FBI's confirmation or correction of the record.

(8) Records.

(a) The licensee shall retain documentation regarding the trustworthiness and reliability of individual employees for three years from the date the individual no longer requires unescorted access to Category 1 or Category 2 quantities of radioactive material.

(b) The licensee shall retain a copy of the current access authorization program procedures as a record for three years after the procedure is no longer needed. If any portion of the procedure is superseded, the licensee shall retain the superseded material for three years after the record is superseded.

(c) The licensee shall retain the list of persons approved for unescorted access authorization for three years after the list is superseded or replaced.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-237-023, filed 12/12/16, effective 1/12/17; WSR 16-13-079, § 246-237-023, filed 6/14/16, effective 7/15/16.]

WAC 246-237-025 Background investigations. (1) Initial investigation. Before allowing an individual unescorted access to Category 1 or Category 2 quantities of radioactive material or to the devices that contain the material, licensees shall complete a background investiga-

tion of the individual seeking unescorted access authorization. The scope of the investigation must encompass at least the seven years preceding the date of the background investigation or since the individual's eighteenth birthday, whichever is shorter. The background investigation must include at a minimum:

(a) Fingerprinting and an FBI identification and criminal history records check in accordance with WAC 246-237-027;

(b) Verification of true identity. Licensees shall verify the true identity of the individual who is applying for unescorted access authorization to ensure that the applicant is who they claim to be. A licensee shall review official identification documents (driver's license; passport; government identification; certificate of birth issued by the state, province, or country of birth) and compare the documents to personal information data provided by the individual to identify any discrepancy in the information. Licensees shall document the type, expiration, and identification number of the identification document, or maintain a photocopy of identifying documents on file in accordance with WAC 246-237-031. Licensees shall certify in writing that the identification was properly reviewed, and shall maintain the certification and all related documents for review upon inspection;

(c) Employment history verification. Licensees shall complete an employment history verification, including military history. Licensees shall verify the individual's employment with each previous employer for the most recent seven years before the date of application;

(d) Verification of education. Licensees shall verify that the individual participated in the education process during the claimed period;

(e) Character and reputation determination. Licensees shall complete reference checks to determine the character and reputation of the individual who has applied for unescorted access authorization. Unless other references are not available, reference checks may not be conducted with any person who is known to be a close member of the individual's family including, but not limited to, the individual's spouse, parents, siblings, or children, or any individual who resides in the individual's permanent household. Reference checks under this chapter must be limited to whether the individual has been and continues to be trustworthy and reliable;

(f) The licensee shall also, to the extent possible, obtain independent information to corroborate that provided by the individual (for example, seek references not supplied by the individual); and

(g) If a previous employer, educational institution, or any other entity with which the individual claims to have been engaged fails to provide information or indicates an inability or unwillingness to provide information within a time frame deemed appropriate by the licensee but at least after ten business days of the request or if the licensee is unable to reach the entity, the licensee shall document the refusal, unwillingness, or inability in the record of investigation; and attempt to obtain the information from an alternate source.

(2) Grandfathering.

(a) Individuals who have been determined to be trustworthy and reliable for unescorted access to Category 1 or Category 2 quantities of radioactive material under the fingerprint orders may continue to have unescorted access to Category 1 and Category 2 quantities of radioactive material without further investigation. These individuals shall be subject to the reinvestigation requirement.

(b) Individuals who have been determined to be trustworthy and reliable under the provisions of 10 C.F.R. Part 73 or the security orders for access to safeguards information, safeguards information-modified handling, or risk-significant material may have unescorted access to Category 1 and Category 2 quantities of radioactive material without further investigation. The licensee shall document that the

individual was determined to be trustworthy and reliable under the provisions of 10 C.F.R. Part 73 or a security order. Security order, in this context, refers to any order that was issued by the NRC that required fingerprints and an FBI criminal history records check for access to safeguards information, safeguards information-modified handling, or risk-significant material such as special nuclear material or large quantities of uranium hexafluoride. These individuals shall be subject to the reinvestigation requirement.

(3) Reinvestigations. Licensees shall conduct a reinvestigation every ten years for any individual with unescorted access to Category 1 or Category 2 quantities of radioactive material. The reinvestigation shall consist of fingerprinting and an FBI identification and criminal history records check in accordance with WAC 246-237-027. The reinvestigations must be completed within ten years of the date on which these elements were last completed.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-237-025, filed 12/12/16, effective 1/12/17; WSR 16-13-079, § 246-237-025, filed 6/14/16, effective 7/15/16.]

WAC 246-237-027 Requirements for criminal history records checks of individuals granted unescorted access to Category 1 or Category 2

quantities of radioactive material. (1) General performance objective and requirements.

(a) Except for those individuals listed in WAC 246-237-029 and those individuals grandfathered under WAC 246-237-025(2), each licensee subject to the provisions of this chapter shall fingerprint each individual who is to be permitted unescorted access to Category 1 or Category 2 quantities of radioactive material. Licensees shall transmit all collected fingerprints to the NRC for transmission to the FBI. The licensee shall use the information received from the FBI as part of the required background investigation to determine whether to grant or deny further unescorted access to Category 1 or Category 2 quantities of radioactive materials for that individual.

(b) The licensee shall notify each affected individual that their fingerprints will be used to secure a review of their criminal history record, and shall inform them of the procedures for revising the record or adding explanations to the record.

(c) Fingerprinting is not required if a licensee is reinstating an individual's unescorted access authorization to Category 1 or Category 2 quantities of radioactive materials if:

(i) The individual returns to the same facility that granted unescorted access authorization within three hundred sixty-five days of the termination of their unescorted access authorization; and

(ii) The previous access authorization was terminated under favorable conditions.

(d) Fingerprints do not need to be taken if an individual who is an employee of a licensee, contractor, manufacturer, or supplier has been granted unescorted access to Category 1 or Category 2 quantities of radioactive material, access to safeguards information, or safeguards information-modified handling by another licensee, based upon a background investigation conducted under this chapter, or the fingerprint orders, or 10 C.F.R. 73. An existing criminal history records check file may be transferred to the licensee asked to grant unescorted access in accordance with the provisions of WAC 246-237-031(3).

(e) Licensees shall use information obtained as part of a criminal history records check solely for the purpose of determining an individual's suitability for unescorted access authorization to Category 1 or Category 2 quantities of radioactive materials, access to safeguards information, or safeguards information-modified handling.

(2) Prohibitions.

(a) Licensees may not base a final determination to deny an individual unescorted access authorization to Category 1 or Category 2 quantities of radioactive material solely on the basis of information received from the FBI involving:

(i) An arrest more than one year old for which there is no information of the disposition of the case; or

(ii) An arrest which resulted in dismissal of the charge or an acquittal.

(b) Licensees may not use information received from a criminal history records check obtained under this chapter in a manner which would infringe upon the rights of any individual under the First Amendment to the Constitution of the United States, nor shall licensees use the information in any way that would discriminate among individuals on the basis of race, religion, national origin, gender, or age.

(3) Procedures for processing of fingerprint checks.

(a) For the purpose of complying with this chapter, licensees shall use an appropriate method to submit to the U.S. Nuclear Regulatory Commission, Director, Division of Facilities and Security, 11545 Rockville Pike, ATTN: Criminal History Program/Mail Stop TWB-05B32M, Rockville, MD 20852, one completed, legible standard fingerprint card

(Form FD-258, ORIMDNRCOOOZ), electronic fingerprint scan or, where practicable, other fingerprint record for each individual requiring unescorted access to Category 1 or Category 2 quantities of radioactive material. Copies of these forms may be obtained by writing the Office of the Chief Information Officer, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001, by calling 1-630-829-9565, or by email to FORMS.Resource@nrc.gov. Guidance on submitting electronic fingerprints can be found at <http://www.nrc.gov/site-help/e-submittals.html>.

(b) Fees for the processing of fingerprint checks are due upon application. Licensees shall submit payment with the application for the processing of fingerprints through corporate check, certified check, cashier's check, money order, or electronic payment, made payable to "U.S. NRC." (For guidance on making electronic payments, contact the Security Branch, Division of Facilities and Security at 301-415-7513.) Combined payment for multiple applications is acceptable. The NRC publishes the amount of the fingerprint check application fee on the NRC's public web site. (To find the current fee amount, go to the electronic submittals page at <http://www.nrc.gov/site-help/e-submittals.html> and see the link for the Criminal History Program under Electronic Submission Systems.)

(c) The NRC will forward to the submitting licensee all data received from the FBI as a result of the licensee's application for criminal history records checks.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-027, filed 6/14/16, effective 7/15/16.]

WAC 246-237-029 Relief from fingerprinting, identification, and criminal history records checks and other elements of background investigations for designated categories of individuals permitted unescorted access to certain radioactive materials. (1) Fingerprinting, and the identification and criminal history records checks required by WAC 246-237-025, 246-237-027 and Section 149 of the Atomic Energy Act of 1954, as amended, and other elements of the background investigation are not required for the following individuals prior to granting unescorted access to Category 1 or Category 2 quantities of radioactive materials:

(a) An employee of the NRC or of the Executive Branch of the U.S. Government who has undergone fingerprinting for a prior U.S. Government criminal history records check;

(b) A Member of Congress;

(c) An employee of a member of Congress or Congressional committee who has undergone fingerprinting for a prior U.S. Government criminal history records check;

(d) The governor of a state or their designated state employee representative;

(e) Federal, state, or local law enforcement personnel;

(f) State Radiation Control Program Directors and State Homeland Security Advisors or their designated state employee representatives;

(g) Agreement state employees conducting security inspections on behalf of the NRC under an agreement executed under Section 274.i. of the Atomic Energy Act;

(h) Representatives of the International Atomic Energy Agency engaged in activities associated with the U.S./International Atomic Energy Agency Safeguards Agreement who have been certified by the NRC;

(i) Emergency response personnel who are responding to an emergency;

(j) Commercial vehicle drivers for road shipments of Category 1 and Category 2 quantities of radioactive material;

(k) Package handlers at transportation facilities such as freight terminals and railroad yards;

(l) Any individual who has an active federal security clearance, provided that they make available the appropriate documentation. Written confirmation from the agency/employer which granted the federal security clearance or reviewed the criminal history records check must be provided to the licensee. The licensee shall retain this documentation for a period of three years from the date the individual no longer requires unescorted access to Category 1 or Category 2 quantities of radioactive material; and

(m) Any individual employed by a service provider licensee for which the service provider licensee has conducted the background investigation for the individual and approved the individual for unescorted access to Category 1 or Category 2 quantities of radioactive material. Written verification from the service provider must be provided to the licensee. The licensee shall retain the documentation for a period of three years from the date the individual no longer requires unescorted access to Category 1 or Category 2 quantities of radioactive material.

(2) Fingerprinting, and the identification and criminal history records checks required by WAC 246-237-025, 246-237-027 and Section 149 of the Atomic Energy Act of 1954, as amended, are not required for an individual who has had a favorably adjudicated U.S. Government

criminal history records check within the last five years, under a comparable U.S. Government program involving fingerprinting and an FBI identification and criminal history records check provided that they make available the appropriate documentation. Written confirmation from the agency or employer who reviewed the criminal history records check must be provided to the licensee. The licensee shall retain this documentation for a period of three years from the date the individual no longer requires unescorted access to Category 1 or Category 2 quantities of radioactive material. These programs include, but are not limited to:

(a) National Agency Check;

(b) Transportation Worker Identification Credentials (TWIC) under 49 C.F.R. Part 1572;

(c) Bureau of Alcohol, Tobacco, Firearms, and Explosives background check and clearances under 27 C.F.R. Part 555;

(d) Health and Human Services security risk assessments for possession and use of select agents and toxins under 42 C.F.R. Part 73;

(e) Hazardous Material security threat assessment for hazardous material endorsement to commercial driver's license under 49 C.F.R. Part 1572; and

(f) U.S. Customs and Border Protection's Free and Secure Trade (FAST) program.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-029, filed 6/14/16, effective 7/15/16.]

WAC 246-237-031 Protection of information. (1) Each licensee who obtains background information on an individual under this chapter shall establish and maintain a system of files and written procedures for protection of the record and the personal information from unauthorized disclosure.

(2) The licensee may not disclose the record or personal information collected and maintained to persons other than the subject individual, their representative, or to those who have a need to have access to the information in performing assigned duties in the process of granting or denying unescorted access to Category 1 or Category 2 quantities of radioactive material, safeguards information, or safeguards information-modified handling. No individual authorized to have access to the information may disseminate the information to any other individual who does not have a need to know.

(3) The personal information obtained on an individual from a background investigation may be provided to another licensee:

(a) Upon the individual's written request to the licensee holding the data to disseminate the information contained in their file; and

(b) The recipient licensee verifies information such as name, date of birth, Social Security number, gender, and other applicable physical characteristics.

(4) The licensee shall make background investigation records obtained under this chapter available for examination by an authorized representative of the department to determine compliance with the applicable rules and laws.

(5) The licensee shall retain all fingerprint and criminal history records (including data indicating no record) received from the FBI, or a copy of these records if the individual's file has been transferred, on an individual for three years from the date the individual no longer requires unescorted access to Category 1 or Category 2 quantities of radioactive material.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-031, filed 6/14/16, effective 7/15/16.]

WAC 246-237-033 Access authorization program review. (1) Each licensee shall be responsible for the continuing effectiveness of the access authorization program. Each licensee shall ensure that access

authorization programs are reviewed to confirm compliance with the requirements of this chapter and that comprehensive actions are taken to correct any noncompliance that is identified. The review program shall evaluate all program performance objectives and requirements. Each licensee shall periodically, at least annually, review the access program content and implementation.

(2) The results of the reviews, along with any recommendations, must be documented. Each review report must identify conditions that are adverse to the proper performance of the access authorization program, the cause of the condition or conditions, and, when appropriate, recommend corrective actions, and corrective actions taken. The licensee shall review the findings and take any additional corrective actions necessary to preclude repetition of the condition, including reassessment of the deficient areas where indicated.

(3) Review records must be maintained for three years.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-033, filed 6/14/16, effective 7/15/16.]

WAC 246-237-041 Security program. (1) Applicability.

(a) Each licensee who possesses an aggregated Category 1 or Category 2 quantity of radioactive material shall establish, implement,

and maintain a security program in accordance with the requirements of this chapter.

(b) An applicant for a new license, and each licensee who would become newly subject to the requirements of this chapter, upon application for modification of its license, shall implement the requirements of this chapter, as appropriate, before taking possession of an aggregated Category 1 or Category 2 quantity of radioactive material.

(c) Any licensee who has not previously implemented the security orders or been subject to the provisions of WAC 246-237-041 through 246-237-057 shall provide written notification to the department at least ninety days before aggregating radioactive material to a quantity that equals or exceeds the Category 2 threshold.

(2) General performance objective. Each licensee shall establish, implement, and maintain a security program designed to monitor and, without delay, detect, assess, and respond to an actual or attempted unauthorized access to Category 1 or Category 2 quantities of radioactive material.

(3) Program features. Each licensee's security program must include the program features, as appropriate, described in WAC 246-237-043 through 246-237-055.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-041, filed 6/14/16, effective 7/15/16.]

WAC 246-237-043 General security program requirements. (1) Security plan.

(a) Each licensee identified in WAC 246-237-041(1) shall develop a written security plan specific to its facilities and operations. The purpose of the security plan is to establish the licensee's overall security strategy to ensure the integrated and effective functioning of the security program required by this chapter. The security plan must, at a minimum:

(i) Describe the measures and strategies used to implement the requirements of this chapter; and

(ii) Identify the security resources, equipment, and technology used to satisfy the requirements of this chapter.

(b) The security plan must be reviewed and approved by the individual with overall responsibility for the security program.

(c) A licensee shall revise its security plan as necessary to ensure the effective implementation of department requirements. The licensee shall ensure that:

(i) The revision has been reviewed and approved by the individual with overall responsibility for the security program; and

(ii) The affected individuals are instructed on the revised plan before the changes are implemented.

(d) The licensee shall retain a copy of the current security plan as a record for three years after the security plan is no longer required. If any portion of the plan is superseded, the licensee shall retain the superseded material for three years after the record is superseded.

(2) Implementing procedures.

(a) The licensee shall develop and maintain written procedures that document how the requirements of this chapter and the security plan will be met.

(b) The implementing procedures and revisions to these procedures must be approved in writing by the individual with overall responsibility for the security program.

(c) The licensee shall retain a copy of the current procedure as a record for three years after the procedure is no longer needed. Superseded portions of the procedure must be retained for three years after the record is superseded.

(3) Training.

(a) Each licensee shall conduct training to ensure those individuals implementing the security program possess and maintain the knowledge, skills, and abilities to carry out their assigned duties and responsibilities effectively. The training must include instruction in:

(i) The licensee's security program and procedures to secure Category 1 or Category 2 quantities of radioactive material, and in the purposes and functions of the security measures employed;

(ii) The responsibility to report promptly to the licensee any condition which causes or may cause a violation of department requirements;

(iii) The responsibility of the licensee to report promptly to the LLEA and licensee any actual or attempted theft, sabotage, or diversion of Category 1 or Category 2 quantities of radioactive material; and

(iv) The appropriate response to security alarms.

(b) In determining those individuals who shall be trained on the security program, the licensee shall consider each individual's assigned activities during authorized use and response to potential situations involving actual or attempted theft, diversion, or sabotage of Category 1 or Category 2 quantities of radioactive material. The ex-

tent of the training must be commensurate with the individual's potential involvement in the security of Category 1 or Category 2 quantities of radioactive material.

(c) Refresher training must be provided at a frequency not to exceed twelve months and when significant changes have been made to the security program. This training must include:

(i) Review of the training requirements of this subsection and any changes made to the security program since the last training;

(ii) Reports on any relevant security issues, problems, and lessons learned;

(iii) Relevant results of department inspections; and

(iv) Relevant results of the licensee's program review and testing and maintenance.

(d) The licensee shall maintain records of the initial and refresher training for three years from the date of the training. The training records must include dates of the training, topics covered, a list of licensee personnel in attendance, and related information.

(4) Protection of information.

(a) Licensees authorized to possess Category 1 or Category 2 quantities of radioactive material shall limit access to, and unauthorized disclosure of, their security plan, implementing procedures,

and the list of individuals who have been approved for unescorted access.

(b) Efforts to limit access shall include the development, implementation, and maintenance of written policies and procedures for controlling access to, and for proper handling and protection against unauthorized disclosure of, the security plan and implementing procedures.

(c) Before granting an individual access to the security plan or implementing procedures, licensees shall:

(i) Evaluate an individual's need to know the security plan or implementing procedures; and

(ii) If the individual has not been authorized for unescorted access to Category 1 or Category 2 quantities of radioactive material, safeguards information, or safeguards information-modified handling, the licensee must complete a background investigation to determine the individual's trustworthiness and reliability. A trustworthiness and reliability determination shall be conducted by the reviewing official and shall include the background investigation elements contained in WAC 246-237-025 (1)(b) through (g).

(d) Licensees need not subject the following individuals to the background investigation elements for protection of information:

(i) The categories of individuals listed in WAC 246-237-029 (1)(a) through (m); or

(ii) Security service provider employees, provided written verification that the employee has been determined to be trustworthy and reliable, by the required background investigation in WAC 246-237-025 (1)(b) through (g), has been provided by the security service provider.

(e) The licensee shall document the basis for concluding that an individual is trustworthy and reliable and should be granted access to the security plan or implementing procedures.

(f) Licensees shall maintain a list of persons currently approved for access to the security plan or implementing procedures. When a licensee determines that a person no longer needs access to the security plan or implementing procedures or no longer meets the access authorization requirements for access to the information, the licensee shall remove the person from the approved list as soon as possible, but no later than seven working days, and take prompt measures to ensure that the individual is unable to obtain the security plan or implementing procedures.

(g) When not in use, the licensee shall store its security plan and implementing procedures in a manner to prevent unauthorized ac-

cess. Information stored in nonremovable electronic form must be password protected.

(h) The licensee shall retain as a record for three years after the document is no longer needed:

(i) A copy of the information protection procedures; and

(ii) The list of individuals approved for access to the security plan or implementing procedures.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-043, filed 6/14/16, effective 7/15/16.]

WAC 246-237-045 LLEA coordination. (1) A licensee subject to this chapter shall coordinate, to the extent practicable, with a LLEA for responding to threats to the licensee's facility, including any necessary armed response. The information provided to the LLEA must include:

(a) A description of the facilities and the Category 1 and Category 2 quantities of radioactive materials along with a description of the licensee's security measures which have been implemented to comply with this chapter; and

(b) A notification that the licensee will request a timely armed response by the LLEA to any actual or attempted theft, sabotage, or diversion of Category 1 or Category 2 quantities of material.

(2) The licensee shall notify the department within three business days if:

(a) The LLEA has not responded to the request for coordination within sixty days of the coordination request; or

(b) The LLEA notifies the licensee that the LLEA does not plan to participate in coordination activities.

(3) The licensee shall document its efforts to coordinate with the LLEA. The documentation must be kept for three years.

(4) The licensee shall coordinate with the LLEA at least every twelve months, or when changes to the facility design or operation adversely affect the potential vulnerability of the licensee's material to theft, sabotage, or diversion.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-045, filed 6/14/16, effective 7/15/16.]

WAC 246-237-047 Security zones. (1) Licensees shall ensure that all aggregated Category 1 and Category 2 quantities of radioactive ma-

terial are used or stored within licensee-established security zones. Security zones may be permanent or temporary.

(2) Temporary security zones must be established as necessary to meet the licensee's transitory or intermittent business activities, such as periods of maintenance, source delivery, and source replacement.

(3) Security zones must, at a minimum, allow unescorted access only to approved individuals through:

(a) Isolation of Category 1 and Category 2 quantities of radioactive materials by the use of continuous physical barriers that allow access to the security zone only through established access control points. A physical barrier is a natural or man-made structure or formation sufficient for the isolation of the Category 1 or Category 2 quantities of radioactive material within a security zone; or

(b) Direct control of the security zone by approved individuals at all times; or

(c) A combination of continuous physical barriers and direct control.

(4) For Category 1 quantities of radioactive material during periods of maintenance, source receipt, preparation for shipment, installation, or source removal or exchange, the licensee shall, at a

minimum, provide sufficient individuals approved for unescorted access to maintain continuous surveillance of sources in temporary security zones and in any security zone in which physical barriers or intrusion detection systems have been disabled to allow such activities.

(5) Individuals not approved for unescorted access to Category 1 or Category 2 quantities of radioactive material must be escorted by an approved individual when in a security zone.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-047, filed 6/14/16, effective 7/15/16.]

WAC 246-237-049 Monitoring, detection, and assessment. (1) Monitoring and detection.

(a) Licensees shall establish and maintain the capability to continuously monitor and detect without delay all unauthorized entries into its security zones. Licensees shall provide the means to maintain continuous monitoring and detection capability in the event of a loss of the primary power source, or provide for an alarm and response in the event of a loss of this capability to continuously monitor and detect unauthorized entries.

(b) Monitoring and detection must be performed by:

(i) A monitored intrusion detection system that is linked to an on-site or off-site central monitoring facility;

(ii) Electronic devices for intrusion detection alarms that will alert nearby facility personnel;

(iii) A monitored video surveillance system;

(iv) Direct visual surveillance by approved individuals located within the security zone; or

(v) Direct visual surveillance by a licensee designated individual located outside the security zone.

(c) A licensee subject to this chapter shall also have a means to detect unauthorized removal of the radioactive material from the security zone. This detection capability must provide:

(i) For Category 1 quantities of radioactive material, immediate detection of any attempted unauthorized removal of the radioactive material from the security zone. Such immediate detection capability must be provided by:

(A) Electronic sensors linked to an alarm;

(B) Continuously monitored video surveillance; or

(C) Direct visual surveillance.

(ii) For Category 2 quantities of radioactive material, weekly verification through physical checks, tamper indicating devices, use, or other means to ensure that the radioactive material is present.

(2) Assessment. Licensees shall immediately assess each actual or attempted unauthorized entry into the security zone to determine whether the unauthorized access was an actual or attempted theft, sabotage, or diversion.

(3) Personnel communications and data transmission. For personnel, and automated or electronic systems, supporting the licensee's monitoring, detection, and assessment systems, licensees shall:

(a) Maintain continuous capability for personnel communication and electronic data transmission and processing among site security systems; and

(b) Provide an alternative communication capability for personnel, and an alternative data transmission and processing capability, in the event of loss of the primary means of communication or data transmission and processing. Alternative communications and data transmission systems may not be subject to the same failure modes as the primary systems.

(4) Response. Licensees shall immediately respond to any actual or attempted unauthorized access to the security zones, or actual or

attempted theft, sabotage, or diversion of Category 1 or Category 2 quantities of radioactive material at licensee facilities or temporary job sites. For any unauthorized access involving an actual or attempted theft, sabotage, or diversion of Category 1 or Category 2 quantities of radioactive material, the licensee's response shall include requesting, without delay, an armed response from the LLEA.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-049, filed 6/14/16, effective 7/15/16.]

WAC 246-237-051 Maintenance and testing. (1) Each licensee subject to this chapter shall implement a maintenance and testing program to ensure that intrusion alarms, associated communication systems, and other physical components of the systems used to secure or detect unauthorized access to radioactive material are maintained in operable condition and are capable of performing their intended function when needed. The equipment relied on to meet the security requirements of this part must be inspected and tested for operability and performance at the manufacturer's suggested frequency. If there is no suggested manufacturer's suggested frequency, the testing must be performed at least annually, not to exceed twelve months.

(2) The licensee shall maintain records of the maintenance and testing activities for three years.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-051, filed 6/14/16, effective 7/15/16.]

WAC 246-237-053 Requirements for mobile devices. Each licensee who possesses mobile devices containing Category 1 or Category 2 quantities of radioactive material must:

(1) Have two independent physical controls that form tangible barriers to secure the material from unauthorized removal when the device is not under direct control and constant surveillance by the licensee; and

(2) For devices in or on a vehicle or trailer, unless the health and safety requirements for a site prohibit the disabling of the vehicle, the licensee shall utilize a method to disable the vehicle or trailer when not under direct control and constant surveillance by the licensee. Licensees shall not rely on the removal of the ignition key to meet this requirement.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-053, filed 6/14/16, effective 7/15/16.]

WAC 246-237-055 Security program review. (1) Each licensee shall be responsible for the continuing effectiveness of their security program. Each licensee shall ensure that the security program is reviewed to confirm compliance with the requirements of this chapter and that comprehensive actions are taken to correct any noncompliance which is identified. The review must include the radioactive material security program content and implementation. Each licensee shall periodically, at least annually, review the security program content and implementation.

(2) The results of the review, along with any recommendations, must be documented. Each review report must identify conditions that are adverse to the proper performance of the security program, the cause of the condition or conditions, and, when appropriate, recommend corrective actions, and corrective actions taken. The licensee shall review the findings and take any additional corrective actions necessary to preclude repetition of the condition or conditions, including reassessment of the deficient areas where indicated.

(3) The licensee shall maintain the review documentation for three years.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-055, filed 6/14/16, effective 7/15/16.]

WAC 246-237-057 Reporting of events. (1) The licensee shall immediately notify the LLEA after determining that an unauthorized entry resulted in an actual or attempted theft, sabotage, or diversion of a Category 1 or Category 2 quantity of radioactive material. As soon as possible after initiating a response, but not at the expense of causing delay or interfering with the LLEA response to the event, the licensee shall notify the department. In no case shall the notification to the department be later than four hours after the discovery of any attempted or actual theft, sabotage, or diversion.

(2) The licensee shall assess any suspicious activity related to possible theft, sabotage, or diversion of Category 1 or Category 2 quantities of radioactive material and notify the LLEA as appropriate. As soon as possible but not later than four hours after notifying the LLEA, the licensee shall notify the department.

(3) The initial telephonic notification required by subsection (1) of this section must be followed within a period of thirty days by a written report submitted to the department. The report must include sufficient information for department analysis and evaluation, including identification of any necessary corrective actions to prevent future instances.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-057, filed 6/14/16, effective 7/15/16.]

WAC 246-237-071 Additional requirements for transfer of Category 1 and Category 2 quantities of radioactive material. A licensee transferring a Category 1 or Category 2 quantity of radioactive material to a licensee of the department, the NRC, or an agreement state shall meet the license verification provisions listed in this section instead of those listed in WAC 246-232-080(4):

(1) Any licensee transferring Category 1 quantities of radioactive material to a licensee of the department, the NRC, or an agreement state, prior to conducting such transfer, shall verify with the department, the NRC's license verification system, or the license issuing authority that the transferee's license authorizes receipt of the type, form, and quantity of radioactive material to be transferred and that the licensee is authorized to receive radioactive material at the location requested for delivery. If the verification is conducted by contacting the license issuing authority, the transferor shall document the verification. For transfers within the same organization, the licensee does not need to verify the transfer.

(2) Any licensee transferring Category 2 quantities of radioactive material to a licensee of the department, the NRC, or an agreement state, prior to conducting such transfer, shall verify with the department, the NRC's license verification system, or the license issuing authority that the transferee's license authorizes receipt of the type, form, and quantity of radioactive material to be transferred. If the verification is conducted by contacting the license issuing authority, the transferor shall document the verification. For transfers within the same organization, the licensee does not need to verify the transfer.

(3) In an emergency where the licensee cannot reach the department or the license issuing authority, and the NRC license verification system is nonfunctional, the licensee may accept a written certification by the transferee that it is authorized by license to receive the type, form, and quantity of radioactive material to be transferred. The certification must include the license number, current revision or amendment number, issuing agency, expiration date and, for a Category 1 shipment, the authorized address. The licensee shall keep a copy of the certification. The certification must be confirmed by use of NRC's license verification system or by contacting the department or the license issuing authority by the end of the next business day.

(4) The transferor shall keep a copy of the verification documentation as a record for three years.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-071, filed 6/14/16, effective 7/15/16.]

WAC 246-237-073 Applicability of physical protection of Category 1 and Category 2 quantities of radioactive material during transit.

(1) For shipments of Category 1 quantities of radioactive material, each shipping licensee shall comply with the requirements for physical protection contained in WAC 246-237-075 (1) and (5); 246-237-077; 246-237-079 (1)(a), (2)(a), and (3); and 246-237-081 (1), (3), (5), (7), and (8).

(2) For shipments of Category 2 quantities of radioactive material, each shipping licensee shall comply with the requirements for physical protection contained in WAC 246-237-075 (2) through (5); 246-237-079 (1)(b), (c), (2)(b), and (3); and 246-237-081 (2), (4), (6), (7), and (8). For those shipments of Category 2 quantities of radioactive material which meet the criteria of WAC 246-231-140(2), the shipping licensee shall also comply with the advance notification provisions of WAC 246-231-140.

(3) The shipping licensee shall be responsible for meeting the requirements of this chapter unless the receiving licensee has agreed in writing to arrange for the in-transit physical protection required under this chapter.

(4) Each licensee that imports or exports Category 1 quantities of radioactive material shall comply with the requirements for physical protection during transit contained in WAC 246-237-075 (1)(b) and (5); 246-237-077; 246-237-079 (1)(a), (2)(a), and (3); and 246-237-081 (1), (3), (5), (7), and (8) for the domestic portion of the shipment.

(5) Each licensee that imports or exports Category 2 quantities of radioactive material shall comply with the requirements for physical protection during transit contained in WAC 246-237-079 (1)(b), (c), and (2)(b); and 246-237-081 (2), (4), (6), (7), and (8) for the domestic portion of the shipment.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-073, filed 6/14/16, effective 7/15/16.]

WAC 246-237-075 Preplanning and coordination of shipment of Category 1 or Category 2 quantities of radioactive material. (1) Each licensee who plans to transport, or deliver to a carrier for transport, licensed material that is a Category 1 quantity of radioactive materi-

al outside the confines of the licensee's facility or other place of use or storage shall:

(a) Preplan and coordinate shipment arrival and departure times with the receiving licensee;

(b) Preplan and coordinate shipment information with the governor or the governor's designee of any state through which the shipment will pass to:

(i) Discuss the state's intention to provide law enforcement escorts; and

(ii) Identify safe havens; and

(c) Document the preplanning and coordination activities.

(2) Each licensee who plans to transport, or deliver to a carrier for transport, licensed material which is a Category 2 quantity of radioactive material outside the confines of the licensee's facility or other place of use or storage shall coordinate the shipment no-later-than arrival time and the expected shipment arrival with the receiving licensee. The licensee shall document the coordination activities.

(3) Each licensee who receives a shipment of a Category 2 quantity of radioactive material shall confirm receipt of the shipment with the originator. If the shipment has not arrived by the no-later-than arrival time, the receiving licensee shall notify the originator.

(4) Each licensee, who transports or plans to transport a shipment of a Category 2 quantity of radioactive material, and determines that the shipment will arrive after the no-later-than arrival time provided pursuant to subsection (2) of this section, shall promptly notify the receiving licensee of the new no-later-than arrival time.

(5) The licensee shall retain a copy of the documentation for preplanning and coordination, and any revision thereof, as a record for three years.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-075, filed 6/14/16, effective 7/15/16.]

WAC 246-237-077 Advance notification of shipment of Category 1 quantities of radioactive material. As specified in subsections (1) and (2) of this section, each licensee shall provide advance notification to the department and the governor of a state, or the governor's designee, of the shipment of licensed material in a Category 1 quantity, through or across the boundary of the state, before transport, or delivery to a carrier for transport, of the licensed material outside the confines of the licensee's facility or other place of use or storage.

(1) Procedures for submitting advance notification.

(a) The notification must be made to the department and to the office of each appropriate governor or governor's designee. The contact information, including telephone and mailing addresses, of governors and governors' designees, is available on the NRC's web site at <https://scp.nrc.gov/special/designee.pdf>. A list of the contact information is also available upon request from the Director, Division of Material Safety, State, Tribal and Rulemaking Programs, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001. Notifications to the department must be made to the attention of the Director, Office of Radiation Protection.

(b) A notification delivered by mail must be postmarked at least seven days before transport of the shipment commences at the shipping facility.

(c) A notification delivered by any means other than mail must reach the department at least four days before transport of the shipment commences and must reach the office of the governor or the governor's designee at least four days before transport of a shipment within or through the state.

(2) Information to be furnished in advance notification of shipment. Each advance notification of shipment of Category 1 quantities

of radioactive material must contain the following information, if available at the time of notification:

(a) The name, address, and telephone number of the shipper, carrier, and receiver of the Category 1 radioactive material;

(b) The license numbers of the shipper and receiver;

(c) A description of the radioactive material contained in the shipment, including the radionuclides and quantities;

(d) The point of origin of the shipment and the estimated time and date when shipment will commence;

(e) The estimated time and date the shipment is expected to enter each state along the route;

(f) The estimated time and date of arrival of the shipment at the destination; and

(g) A point of contact, with a telephone number, for current shipment information.

(3) Revision notice.

(a) The licensee shall provide any information not previously available at the time of the initial notification, as soon as the information becomes available but not later than commencement of the shipment, to the governor of the state or the governor's designee and to the department.

(b) A licensee shall promptly notify the governor of the state or the governor's designee of any changes to the information provided in accordance with subsections (2) and (3)(a) of this section. The licensee shall also immediately notify the department of any such changes.

(4) Cancellation notice. Each licensee who cancels a shipment for which advance notification has been sent shall send a cancellation notice to the department and to the governor of each state or to the governor's designee previously notified. The licensee shall send the cancellation notice before the shipment would have commenced or as soon thereafter as possible. The licensee shall state in the notice that it is a cancellation and identify the advance notification which is being canceled.

(5) Records. The licensee shall retain a copy of the advance notification and any revision and cancellation notices as a record for three years.

(6) Protection of information. State officials, state employees, and other individuals, whether or not licensees of the department, NRC, or an agreement state who receive schedule information of the kind specified in subsection (2) of this section shall protect that information against unauthorized disclosure as specified in WAC 246-237-043(4).

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-237-077, filed 12/12/16, effective 1/12/17; WSR 16-13-079, § 246-237-077, filed 6/14/16, effective 7/15/16.]

WAC 246-237-079 Requirements for physical protection of Category 1 and Category 2 quantities of radioactive material during shipment.

(1) Shipments by road.

(a) Each licensee who transports, or delivers to a carrier for transport, in a single shipment, a Category 1 quantity of radioactive material shall:

(i) Ensure that movement control centers are established that maintain position information from a remote location. These control centers must monitor shipments twenty-four hours a day, seven days a week, and have the ability to communicate immediately, in an emergency, with the appropriate law enforcement agencies.

(ii) Ensure that redundant communications are established that allow the transport to contact the escort vehicle (when used) and movement control center at all times. Redundant communications may not be subject to the same interference factors as the primary communication.

(iii) Ensure that shipments are continuously and actively monitored by a telemetric position monitoring system or an alternative tracking system reporting to a movement control center. A movement control center must provide positive confirmation of the location, status, and control over the shipment. The movement control center must be prepared to promptly implement preplanned procedures in response to deviations from the authorized route or a notification of actual, attempted, or suspicious activities related to the theft, loss, or diversion of a shipment. These procedures will include, but not be limited to, the identification of and contact information for the appropriate LLEA along the shipment route.

(iv) Provide an individual to accompany the driver for those highway shipments with a driving time period greater than the maximum number of allowable hours of service in a twenty-four hour duty day as established by the Department of Transportation Federal Motor Carrier Safety Administration. The accompanying individual may be another driver.

(v) Develop written normal and contingency procedures to address:

(A) Notifications to the communication center and law enforcement agencies;

(B) Communication protocols. Communication protocols must include a strategy for the use of authentication codes and duress codes and provisions for refueling or other stops, detours, and locations where communication is expected to be temporarily lost;

(C) Loss of communications; and

(D) Responses to an actual or attempted theft or diversion of a shipment.

(vi) Each licensee who makes arrangements for the shipment of Category 1 quantities of radioactive material shall ensure that drivers, accompanying personnel, and movement control center personnel have access to the normal and contingency procedures.

(b) Each licensee who transports Category 2 quantities of radioactive material shall maintain constant control or surveillance during transit and have the capability for immediate communication to summon appropriate response or assistance.

(c) Each licensee who delivers to a carrier for transport, in a single shipment, a Category 2 quantity of radioactive material shall:

(i) Use carriers who have established package tracking systems. An established package tracking system is a documented, proven, and reliable system routinely used to transport objects of value. In order for a package tracking system to maintain constant control or surveil-

lance, the package tracking system must allow the shipper or transporter to identify when and where the package was last and when it should arrive at the next point of control.

(ii) Use carriers who maintain constant control or surveillance during transit and have the capability for immediate communication to summon appropriate response or assistance; and

(iii) Use carriers who have established tracking systems that require an authorized signature prior to releasing the package for delivery or return.

(2) Shipments by rail.

(a) Each licensee who transports, or delivers to a carrier for transport, in a single shipment, a Category 1 quantity of radioactive material shall:

(i) Ensure that rail shipments are monitored by a telemetric position monitoring system or an alternative tracking system reporting to the licensee, third-party, or railroad communications center. The communications center shall provide positive confirmation of the location of the shipment and its status. The communications center shall implement preplanned procedures in response to deviations from the authorized route or to a notification of actual, attempted, or suspicious activities related to the theft or diversion of a shipment.

These procedures will include, but not be limited to, the identification of and contact information for the appropriate LLEA along the shipment route.

(ii) Ensure that periodic reports to the communications center are made at preset intervals.

(b) Each licensee who transports, or delivers to a carrier for transport, in a single shipment, a Category 2 quantity of radioactive material shall:

(i) Use carriers who have established package tracking systems. An established package tracking system is a documented, proven, and reliable system routinely used to transport objects of value. In order for a package tracking system to maintain constant control or surveillance, the package tracking system must allow the shipper or transporter to identify when and where the package was last and when it should arrive at the next point of control.

(ii) Use carriers who maintain constant control or surveillance during transit and have the capability for immediate communication to summon appropriate response or assistance; and

(iii) Use carriers who have established tracking systems that require an authorized signature prior to releasing the package for delivery or return.

(3) Investigations. Each licensee who makes arrangements for the shipment of Category 1 quantities of radioactive material shall immediately conduct an investigation upon discovery that a Category 1 shipment is lost or missing. Each licensee who makes arrangements for the shipment of Category 2 quantities of radioactive material shall immediately conduct an investigation, in coordination with the receiving licensee, of any shipment that has not arrived by the designated no-later-than arrival time.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-079, filed 6/14/16, effective 7/15/16.]

WAC 246-237-081 Reporting requirements. (1) The shipping licensee shall notify the appropriate LLEA and the department within one hour of its determination that a shipment of Category 1 quantities of radioactive material is lost or missing. The appropriate LLEA would be the law enforcement agency in the area of the shipment's last confirmed location. During the investigation required by WAC 246-237-079(3), the shipping licensee will provide agreed upon updates to the department on the status of the investigation.

(2) The shipping licensee shall notify the department within four hours of its determination that a shipment of Category 2 quantities of

radioactive material is lost or missing. If, after twenty-four hours of the determination that the shipment is lost or missing, the radioactive material has not been located and secured, the licensee shall immediately notify the department.

(3) The shipping licensee shall notify the designated LLEA along the shipment route as soon as possible upon discovery of any actual or attempted theft or diversion of a shipment or suspicious activities related to the theft or diversion of a shipment of a Category 1 quantity of radioactive material. As soon as possible after notifying the LLEA, the licensee shall notify the department upon discovery of any actual or attempted theft or diversion of a shipment, or any suspicious activity related to the shipment of Category 1 radioactive material.

(4) The shipping licensee shall notify the department as soon as possible upon discovery of any actual or attempted theft or diversion of a shipment, or any suspicious activity related to the shipment, of a Category 2 quantity of radioactive material.

(5) The shipping licensee shall notify the department and the LLEA as soon as possible upon recovery of any lost or missing Category 1 quantities of radioactive material.

(6) The shipping licensee shall notify the department as soon as possible upon recovery of any lost or missing Category 2 quantities of radioactive material.

(7) The initial telephonic notification required by subsections (1) through (4) of this section must be followed within a period of thirty days by a written report submitted to the department by an appropriate method. A written report is not required for notifications of suspicious activities required by subsections (3) and (4) of this section. In addition, the licensee shall provide a copy of the written report to the department. The report must set forth the following information:

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

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

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

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

(e) Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed material.

(8) Subsequent to filing the written report, the licensee shall also report any additional substantive information about the loss or theft to the department within thirty days after the licensee learns of such information.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-081, filed 6/14/16, effective 7/15/16.]

WAC 246-237-101 Form of records. Each record required by this chapter must be legible throughout the retention period specified by department rule. The record may be the original or a reproduced copy or a microform, provided the copy or microform is authenticated by authorized personnel and 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 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 shall maintain adequate safeguards against tampering with, and loss of, records.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-101, filed 6/14/16, effective 7/15/16.]

WAC 246-237-103 Record retention. Licensees shall maintain records required by this chapter for the period specified by the appropriate rule. If a retention period is not otherwise specified, these records must be retained until the department terminates the facility's license. All records related to this chapter may be destroyed upon department termination of the facility license.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-103, filed 6/14/16, effective 7/15/16.]

WAC 246-237-105 Inspections. (1) Each licensee shall afford the department, at all reasonable times, opportunity to inspect Category 1 or Category 2 quantities of radioactive material and the premises and facilities wherein the nuclear material is used, produced, or stored.

(2) Each licensee shall make available to the department for inspection, upon reasonable notice, records kept by the licensee pertaining to receipt, possession, use, acquisition, import, export, or transfer of Category 1 or Category 2 quantities of radioactive material.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, § 246-237-105, filed 6/14/16, effective 7/15/16.]

WAC 246-237-900 Appendix A: Table 1—Category 1 and Category 2

thresholds. Terabecquerel (TBq) values are the regulatory standard. The curie (Ci) values specified are obtained by converting from the TBq value. The curie values provided for practical usefulness only.

Radioactive material	Category 1 (TBq)	Category 1 (Ci)	Category 2 (TBq)	Category 2 (Ci)
Americium-241	60	1,620	0.6	16.2
Americium-241/Be	60	1,620	0.6	16.2
Californium-252	20	540	0.2	5.40
Cobalt-60	30	810	0.3	8.10
Curium-244	50	1,350	0.5	13.5
Cesium-137	100	2,700	1	27.0
Gadolinium-153	1,000	27,000	10	270
Iridium-192	80	2,160	0.8	21.6
Plutonium-238	60	1,620	0.6	16.2
Plutonium-239/Be	60	1,620	0.6	16.2
Promethium-147	40,000	1,080,000	400	10,800
Radium-226	40	1,080	0.4	10.8
Selenium-75	200	5,400	2	54.0
Strontium-90	1,000	27,000	10	270
Thulium-170	20,000	540,000	200	5,400
Ytterbium-169	300	8,100	3	81.0

Note: Calculations Concerning Multiple Sources or Multiple Radionuclides

The "sum of fractions" methodology for evaluating combinations of multiple sources or multiple radionuclides is to be used in determining whether a location meets or exceeds the threshold and is thus subject to the requirements of this chapter.

I. If multiple sources of the same radionuclide or multiple radionuclides are aggregated at a location, the sum of the ratios of the total activity of each of the radionuclides must be determined to ver-

ify whether the activity at the location is less than the Category 1 or Category 2 thresholds of Table 1, as appropriate. If the calculated sum of the ratios, using the equation below, is greater than or equal to 1.0, then the applicable requirements of this chapter apply.

II. First determine the total activity for each radionuclide from Table 1. This is done by adding the activity of each individual source, material in any device, and any loose or bulk material that contains the radionuclide. Then use the equation below to calculate the sum of the ratios by inserting the total activity of the applicable radionuclides from Table 1 in the numerator of the equation and the corresponding threshold activity from Table 1 in the denominator of the equation. Calculations must be performed in metric values (TBq) and the numerator and denominator values must be in the same units.

R_1 = total activity for radionuclide 1

R_2 = total activity for radionuclide 2

R_N = total activity for radionuclide n

AR_1 = activity threshold for radionuclide 1

AR_2 = activity threshold for radionuclide 2

AR_N = activity threshold for radionuclide n

$$\sum_1^n \left[\frac{R_1}{AR_1} + \frac{R_2}{AR_2} + \frac{R_n}{AR_n} \right] \geq 1.0$$

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-079, §
246-237-900, filed 6/14/16, effective 7/15/16.]

Reviser's note: The brackets and enclosed material in the text of the above section occurred in
the copy filed by the agency.

Chapter 246-243 WAC

RADIATION PROTECTION—INDUSTRIAL RADIOGRAPHY

Last Update: 6/10/16

WAC

- 246-243-001 Purpose.
- 246-243-010 Scope.
- 246-243-020 Definitions, abbreviations, and acronyms.
- 246-243-030 Conducting industrial radiography operations.
- 246-243-040 Equipment performance requirements.
- 246-243-042 Labeling, storage, and transportation.
- 246-243-044 Records of receipt and transfer of sealed sources.
- 246-243-047 Radiation safety officer for industrial radiography.
- 246-243-050 Internal inspection program and training.
- 246-243-060 Locking of radiographic exposure devices.
- 246-243-070 Storage precautions.
- 246-243-080 Radiation survey instruments.
- 246-243-090 Leak testing, repair, tagging, opening, modification, and replacement of sealed sources.
- 246-243-100 Quarterly inventory.
- 246-243-110 Utilization logs.
- 246-243-120 Inspection and maintenance of radiographic exposure devices, transport and storage con-

tainers, associated equipment, source changers, and survey instruments.

- 246-243-130 Limitations—Personal radiation safety requirements for radiographers and radiographers' assistants.
- 246-243-140 Operating and emergency procedures.
- 246-243-141 Copies of operating and emergency procedures.
- 246-243-150 Personnel monitoring control.
- 246-243-160 Supervision of radiographers' assistants.
- 246-243-170 Security—Precautionary procedures in radiographic operations.
- 246-243-180 Posting.
- 246-243-190 Radiation surveys and survey records.
- 246-243-195 Reporting.
- 246-243-200 Records required at temporary job sites.
- 246-243-203 Form of records.
- 246-243-205 Temporary job site notification.
- 246-243-220 Special requirements for permanent radiographic installation.
- 246-243-230 Appendix A—Minimum subjects to be covered in training radiographers.
- 246-243-240 Appendix B—General guidelines for inspection of radiography equipment.
- 246-243-250 Appendix C—Radiographer certification.

DISPOSITION OF SECTIONS FORMERLY CODIFIED IN THIS CHAPTER

- 246-243-210 Special requirements for enclosed radiography. [Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-243-210, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW

70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-210, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-210, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-155, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-155, filed 12/8/80; Order 1084, § 402-36-155, filed 1/14/76.] Repealed by WSR 00-08-013, filed 3/24/00, effective 4/24/00. Statutory Authority: RCW 70.98.050.

WAC 246-243-001 Purpose. The regulations in this chapter establish radiation safety requirements for persons utilizing sources of radiation for industrial radiography. The requirements of this chapter are in addition to and not in substitution for other requirements of these regulations.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-001, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-001, filed 12/27/90, effective 1/31/91; Order 1084, § 402-36-010, filed 1/14/76; Order 1, § 402-36-010, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-010 Scope. The regulations in this chapter apply to all licensees who use sources of radiation for industrial radiography: Provided, however, that nothing in this chapter shall apply to the use of sources of radiation in the healing arts.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-010, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-243-010, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-010, filed 12/27/90, effective 1/31/91; Order 1084, § 402-36-020, filed 1/14/76; Order 1, § 402-36-020, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-020 Definitions, abbreviations, and acronyms. The definitions, abbreviations, and acronyms in this section and in WAC 246-220-010 apply throughout this chapter, unless the context clearly indicates otherwise.

(1) **"Annual refresher safety training"** means a review conducted or provided by the licensee for its employees on radiation safety aspects of industrial radiography. The review may include, as appropriate, the results of internal inspections, new procedures or equipment, new or revised regulations, accidents or errors that have been ob-

served, and should also provide opportunities for employees to ask safety questions.

(2) **"Associated equipment"** means equipment that is used in conjunction with a radiographic exposure device to make radiographic exposures which drives, guides, or comes in contact with the source, for example guide tube, control tube, control (drive) cable, removable source stop, "J" tube and collimator when it is used as an exposure head.

(3) **"Certifying entity"** means an independent certifying organization meeting the requirements in WAC 246-243-250 Appendix C or an agreement state meeting the requirements in WAC 246-243-250 Appendix C, subsections (2) and (3).

(4) **"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.

(5) **"Control (drive) cable"** means the cable that is connected to the source assembly and used to drive the source to and from the exposure location.

(6) **"Control drive mechanism"** means a device that enables the source assembly to be moved to and from the exposure device.

(7) **"Control tube"** means a protective sheath for guiding the control cable. The control tube connects the control drive mechanism to the radiographic exposure device.

(8) **"Exposure head"** means a device that locates the gamma radiography sealed source in the selected working position. (An exposure head is also known as a source stop.)

(9) **"Field station"** means a facility where licensed material may be stored or used and from which equipment is dispatched.

(10) **"Guide tube (projection sheath)"** means a flexible or rigid 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.

(11) **"Hands-on experience"** means experience in all of those areas considered to be directly involved in the radiography process.

(12) **"Independent certifying organization"** means an independent organization that meets all of the criteria of WAC 246-243-250 Appendix C.

(13) **"Industrial radiography"** means the examination of the macroscopic structure of materials by nondestructive methods utilizing sources of radiation to make radiographic images. Industrial radiog-

raphy as used in this chapter does not include well logging operations.

(14) **"Lay-barge radiography"** means industrial radiography performed on any water vessel used for laying pipe.

(15) **"Offshore platform radiography"** means industrial radiography conducted from a platform over a body of water.

(16) **"Permanent radiographic installation"** means an enclosed shielded room, cell or vault, not located at a temporary job site, in which radiography is performed, regardless of ownership.

(17) **"Practical examination"** means a demonstration through practical application of the safety rules and principles in industrial radiography including use of all appropriate equipment and procedures.

(18) **"Radiation safety officer for industrial radiography"** means an individual with the responsibility for the overall radiation safety program on behalf of the licensee and who meets the requirements of WAC 246-243-047.

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

(20) **"Radiographer certification"** means written approval received from a certifying entity stating that an individual has satisfactorily met certain established radiation safety, testing, and experience criteria.

(21) **"Radiographer's assistant"** means any individual who, under the personal supervision of a radiographer, uses sources of radiation, related handling tools, or radiation survey instruments in industrial radiography.

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

(23) **"Radiographic operations"** means all activities associated with the presence of radioactive sources in a radiographic exposure device during use of the device or transport (except when being transported by a common or contract carrier), to include surveys to confirm the adequacy of boundaries, setting up equipment and any activity inside restricted area boundaries.

(24) **"S-tube"** means a tube through which the radioactive source travels when inside a radiographic exposure device.

(25) **"Shielded position"** means the location within the radiographic exposure device or source changer where the sealed source is secured and restricted from movement.

(26) **"Source assembly"** means an assembly that consists of the sealed source and a connector that attaches the source to the control cable. The source assembly may also include a stop ball used to secure the source in the shielded position.

(27) **"Source changer"** means a device designed and used for replacement of sealed sources in radiographic exposure devices, including those also used for transporting and storage of sealed sources.

(28) **"Storage area"** means any location, facility, or vehicle which is used to store or to secure a radiographic exposure device, a storage container, or a sealed source when it is not in use and which is locked or has a physical barrier to prevent accidental exposure, tampering with, or unauthorized removal of the device, container, or source.

(29) **"Storage container"** means a container in which sealed sources are secured and stored.

(30) **"Temporary job site"** means a location where radiographic operations are conducted and where licensed material may be stored other than those locations of use authorized on the license.

(31) **"Underwater radiography"** means industrial radiography performed when the radiographic exposure device or related equipment are beneath the surface of the water.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-020, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-020, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-020, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-020, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-020, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-025, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-025, filed 12/8/80; Order 1084, § 402-36-025, filed 1/14/76.]

WAC 246-243-030 Conducting industrial radiography operations. (1)

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 WAC 246-243-130(2) (radiographer's as-

sistant). 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.

(2) All radiographic operations conducted at locations of use authorized on the license must be conducted in a permanent radiographic installation, unless specifically authorized by the department.

(3) Offshore platform, lay-barge, or underwater radiography shall be performed only by licensees whose license specifically authorizes such activity. Such operations fall under the jurisdiction of the United States Nuclear Regulatory Commission when conducted outside of the territorial waters of the state of Washington.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-030, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-030, filed 3/24/00, effective 4/24/00. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-030, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-027, filed 9/16/83.]

WAC 246-243-040 Equipment performance requirements. Equipment

used in industrial radiography operations must meet the following minimum criteria:

(1)(a) Each radiographic exposure device, source assembly or sealed source, and all associated equipment must meet the requirements specified in American National Standards 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 may be purchased from American National Standards Institute, Inc., 25 West 43rd Street, New York, New York, 10036; telephone: 212-642-4900. Copies of the document are available for inspection at the Department of Health, Office of Radiation Protection, Olympia, Washington. A copy of the document is also on file at the National Archives and Records Administration. For information on the availability of this material at the National Archives and Records Administration call 202-741-6030, or go to: http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.

(b) Engineering analysis may be submitted by an applicant or licensee to demonstrate the applicability of previously performed testing on similar individual radiography equipment components. Upon re-

view, the department may find this an acceptable alternative to actual testing of the component pursuant to the above referenced standard.

(c) Notwithstanding (a) of this subsection, 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 realistically exert on the lever or crankshaft of the drive mechanism.

(2) In addition to the requirements specified in subsection (1) of this section, the following requirements apply to radiographic exposure devices, source changers, source assemblies and sealed sources.

(a) The licensee shall ensure that each radiographic exposure device has attached to it a durable, legible, clearly visible label bearing the:

(i) Chemical symbol and mass number of the radionuclide in the device;

(ii) Activity and the date on which this activity was last measured;

(iii) Model (or product code) and serial number of the sealed source;

(iv) Manufacturer's identity of the sealed source; and

(v) Licensee's name, address, and telephone number.

(b) Radiographic exposure devices intended for use as Type B transport containers must meet the applicable requirements of 10 C.F.R. Part 71.

(c) Modification of radiographic exposure devices, source changers, and source assemblies and associated equipment is prohibited, unless the design of any replacement component, including source holder, source assembly, controls or guide tubes would not compromise the design safety features of the system.

(3) In addition to the requirements specified in subsections (1) and (2) of this section, 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.

(a) 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.

(b) The device must automatically secure the source assembly when it is cranked back into the fully shielded position within the device. The securing system may only be released by means of a deliberate operation on the exposure device.

(c) The outlet fittings, lock box, and drive cable fitting 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.

(d)(i) 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."

(ii) The label may not interfere with the safe operation of the exposure device or associated equipment.

(e) 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 likely to be encountered during use.

(f) Guide tubes must be used when moving the source out of the device.

(g) An exposure head or similar device designed to prevent the source assembly from passing out of the end of the guide tube must be attached to the outermost end of the guide tube during radiographic operations.

(h) The guide tube exposure head connection must be able to withstand the tensile test for control units specified in ANSI N432-1980.

(i) Source changers 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.

(4) All radiographic exposure devices and associated equipment in use after January 1, 1998, must comply with the requirements of this section.

(5) The maximum exposure rate limits for storage containers and source changers with the sealed source in the shielded position are:

(a) 2 millisieverts (200 millirem) per hour at any exterior surface; and

(b) 0.1 millisieverts (10 millirem) per hour at one meter from any exterior surface.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-040, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 99-05-012, § 246-243-040, filed 2/5/99, effective

3/8/99; WSR 94-01-073, § 246-243-040, filed 12/9/93, effective 1/9/94.
Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodi-
fied as § 246-243-040, filed 12/27/90, effective 1/31/91. Statutory
Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-030,
filed 12/8/80; Order 1084, § 402-36-030, filed 1/14/76; Order 1, §
402-36-030, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-042 Labeling, storage, and transportation. (1) The licensee may not use a source changer or a container to store licensed 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 in conventional colors, that is, magenta, purple or black on a yellow background, having a minimum diameter of 25 mm, and the wording:

CAUTION (OR "DANGER")

RADIOACTIVE MATERIAL

NOTIFY CIVIL AUTHORITIES IF FOUND

(OR "NAME OF COMPANY")

(2) The licensee may not transport licensed material unless the material is packaged, and the package is labeled, marked, and accompa-

nied with appropriate shipping papers in accordance with regulations set out in 10 C.F.R. Part 71.

(3) Locked radiographic exposure devices and storage containers must be physically secured to prevent tampering or removal by unauthorized personnel. The licensee shall store licensed material in a manner which will minimize danger from explosion or fire.

(4) The licensee shall lock and physically secure the transport package containing licensed material in the transporting vehicle to prevent accidental loss, tampering, or unauthorized removal of the licensed material from the vehicle.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-042, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-042, filed 3/24/00, effective 4/24/00.]

WAC 246-243-044 Records of receipt and transfer of sealed sources. (1) Each licensee shall maintain records showing the receipts and transfers of sealed sources and of devices using depleted uranium (DU) for shielding and retain each record for three years after it is made.

(2) These records must include the date, shipper or destination, 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 sealed source or device, as appropriate.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-044, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-044, filed 3/24/00, effective 4/24/00.]

WAC 246-243-047 Radiation safety officer for industrial radiography. The radiation safety officer (RSO) 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 program.

(1) The minimum qualifications, training, and experience for RSOs for industrial radiography are as follows:

(a) Completion of the training and testing requirements of WAC 246-243-130(1);

(b) Two thousand hours of hands-on experience as a qualified radiographer in industrial radiographic operations utilizing sealed radioactive material; and

(c) Formal training in the establishment and maintenance of a radiation protection program.

(2) The department will consider alternatives when the RSO has appropriate training or 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.

(3) The specific duties and authorities of the RSO include, but are not limited to:

(a) Establishing and overseeing all operating, emergency, and ALARA procedures as required by chapter 246-221 WAC, and reviewing them regularly to ensure that the procedures in use conform to current chapter 246-221 WAC requirements, conform to other department regulations and to the license conditions;

(b) Overseeing and approving all phases of the training program for radiographic personnel, ensuring that appropriate and effective radiation protection practices are taught;

(c) 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;

(d) Ensuring that personnel monitoring devices are calibrated and used properly by occupationally exposed personnel, that records are kept of the monitoring results, and that timely notifications are made as required by WAC 246-221-260; and

(e) Ensuring that operations are conducted safely and to assume control for instituting corrective actions including stopping of operations when necessary.

(4) The licensee will have until January 1, 2001, to meet the requirements of subsection (1) or (2) of this section.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-047, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-047, filed 3/24/00, effective 4/24/00.]

WAC 246-243-050 Internal inspection program and training. (1)

Each licensee shall conduct the internal inspection of job performance required by WAC 246-235-084 at intervals not to exceed six months. Except as provided in subsection (1)(d) of this section, the radiation safety officer (RSO) or designee shall conduct an inspection program of the job performance of each radiographer and radiographer's assistant to ensure that the department's regulations, license require-

ments, and the licensee's operating and emergency procedures are followed. The inspection program shall:

(a) Include observation of the performance of each radiographer and radiographer's assistant during an actual industrial radiographic operation, at intervals not to exceed six months; and

(b) Provide that, if a radiographer or a radiographer's assistant has not participated in an industrial radiographic operation for more than six months since the last inspection, the radiographer must demonstrate knowledge of the training requirements of WAC 246-243-130 (1)(c) and the radiographer's assistant must redemonstrate knowledge of the training requirements of WAC 246-243-130 (2)(b) by a practical examination before these individuals can next participate in a radiographic operation.

(c) The department may consider alternatives in situations where the individual serves as both radiographer and RSO.

(d) In operations where a single individual serves as both radiographer and RSO, and performs all radiography operations, an inspection program is not required.

(2) The licensee shall provide annual refresher safety training for each radiographer and radiographer's assistant at intervals not to exceed twelve months.

(3) Each licensee shall maintain the following records for three years after the record is made:

(a) For semiannual inspection of job performance, the record shall include:

- (i) A list of the items checked; and
- (ii) Any noncompliances observed by the RSO;

(b) For annual refresher safety training, the record shall include:

- (i) A list of the topics discussed;
- (ii) The dates the training was conducted; and
- (iii) Names of the instructors and attendees.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-050, filed 3/24/00, effective 4/24/00. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 92-06-008 (Order 245), § 246-243-050, filed 2/21/92, effective 3/23/92. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-050, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-035, filed 9/16/83.]

WAC 246-243-060 Locking of radiographic exposure devices. (1)

Each radiographic exposure device shall be provided with a lock or

outerlocked container designed to prevent unauthorized or accidental production of radiation or removal or exposure of a sealed source and shall be locked when returned to the shielded position at all times. If it is a keyed-lock, the key shall be removed at all times when not under the direct surveillance of a radiographer or a radiographer's assistant except at permanent radiographic installations as stated in WAC 246-243-170. In addition, during radiographic operations the sealed source assembly shall be locked in the shielded position each time the source is returned to that position.

(2) Each sealed source storage container and source changer shall 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 shall be kept locked (and if a keyed-lock, with the key removed at all times) when containing sealed sources except when under the direct surveillance of a radiographer or a radiographer's assistant.

(3) Radiographic exposure devices, source changers, and storage containers, prior to being moved from one location to another and also prior to being secured at a given location, shall be locked and surveyed to assure that the sealed source is in the shielded position.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-060, filed 3/24/00, effective 4/24/00. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-060, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-060, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-040, filed 12/8/80; Order 1084, § 402-36-040, filed 1/14/76; Order 1, § 402-36-040, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-070 Storage precautions. (1) Locked radiographic exposure devices and storage containers shall be physically secured to prevent tampering or removal by unauthorized personnel.

(2) At least one calibrated and operable radiation survey instrument shall be available at the storage area whenever a radiographic exposure device, a storage container, or source is being placed in storage.

[Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-243-070, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-070, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR

81-01-011 (Order 1570), § 402-36-050, filed 12/8/80; Order 1084, § 402-36-050, filed 1/14/76; Order 1, § 402-36-050, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-080 Radiation survey instruments. (1) The licensee shall maintain sufficient calibrated and operable radiation survey instruments at each location where radioactive material is present to make physical radiation surveys as required by this part and chapter 246-221 WAC. Instrumentation required by this section shall be capable of measuring a range from 0.02 millisieverts (2 millirems) per hour through 0.01 sievert (1 rem) per hour.

(2) Each radiation survey instrument shall be calibrated:

(a) At intervals not to exceed six months and after each instrument servicing except for battery changes;

(b) Such that accuracy within ± 20 percent of the calibration source can be demonstrated at each point checked; and

(c) 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 for digital instruments at three points between 0.02 and 10 millisieverts (2 and 1000 millirems) per hour.

(3) Records shall be maintained of these calibrations for three years after the calibration date for inspection by the department.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-080, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-080, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-080, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-080, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-060, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-060, filed 12/8/80; Order 1084, § 402-36-060, filed 1/14/76; Order 1, § 402-36-060, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-090 Leak testing, repair, tagging, opening, modification, and replacement of sealed sources. (1) The replacement of any sealed source fastened to or contained in a radiographic exposure device and leak testing, repair, tagging, opening, or any other modification of any sealed source shall be performed only by persons specifically authorized to do so by the department, the United States Nuclear Regulatory Commission, or any agreement state.

(2) Each sealed source shall be tested for leakage at intervals not to exceed six months. 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 six months. In the absence of a certificate from a transferor that a test has been made within the six-month period prior to the transfer, the sealed source shall not be put into use until tested and results obtained.

(3) The leak test shall be capable of detecting the presence of 185 becquerels (0.005 microcurie) of removable contamination on the sealed source. An acceptable leak test for sealed sources in the possession of a radiography licensee would be to test at the nearest accessible point to the sealed source storage position, or other appropriate measuring point where contamination might accumulate, by a procedure specifically approved in a license condition. Records of leak test results shall be kept in units of becquerels (microcuries) and maintained for inspection by the department for three years after the leak test is performed.

(4) Any test conducted under subsections (2) and (3) of this section which reveals the presence of 185 becquerels (0.005 microcurie) or more of removable radioactive material shall be considered evidence

that the sealed source is leaking. The licensee shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed in accordance with regulations of the department. Within five days after obtaining results of the test, the licensee shall file a report with the department describing the involved equipment, the test results, and the corrective action taken.

(5) Each exposure device using depleted uranium (DU) shielding and an "S" tube configuration must be tested for DU contamination at intervals not to exceed twelve months. The analysis must be capable of detecting the presence of 185 becquerels (0.005 microcuries) of radioactive material on the test sample and must be performed by a person specifically authorized by the department, the United States Nuclear Regulatory Commission or an agreement state to perform the analysis. If testing reveals the presence of 185 becquerels (0.005 microcuries) or more of removable DU contamination, the exposure device must be removed from use until an evaluation of the wear on the S-tube has been made. If the evaluation reveals that 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 in storage and not in use. Before using or transferring such a device however, the device must be tested

for DU contamination if the interval of storage exceeded twelve months. A record of the DU leak-test results shall be kept in units of becquerels (microcuries) and maintained for inspection by the department for three years after the DU leak test is made or until the source in storage is removed. Licensees will have until January 1, 2001, to comply with the DU leak testing requirements of this section.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-090, filed 3/24/00, effective 4/24/00; WSR 99-05-012, § 246-243-090, filed 2/5/99, effective 3/8/99; WSR 94-01-073, § 246-243-090, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-090, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-090, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-36-070, filed 12/11/86; WSR 83-19-050 (Order 2026), § 402-36-070, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-070, filed 12/8/80; Order 1084, § 402-36-070, filed 1/14/76; Order 1, § 402-36-070, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-100 Quarterly inventory. Each licensee shall conduct a quarterly physical inventory to account for all sealed sources and for devices containing depleted uranium (DU) received or possessed. The records of the inventories shall be maintained for three years from the date of inventory for inspection by the department and shall include:

- (1) Exposure device or source changer make, model, and serial number;
- (2) Sealed source serial number and manufacturer;
- (3) Radionuclide and current activity in becquerels (curies) or mass (for DU) in each device;
- (4) Location of sealed source or device/changer;
- (5) Date of inventory;
- (6) Name of person who performed inventory.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-100, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-100, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-100, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-100, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-

080, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-080, filed 12/8/80; Order 1084, § 402-36-080, filed 1/14/76; Order 1, § 402-36-080, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-110 Utilization logs. (1) Each licensee shall maintain current logs, which shall be kept available for inspection by the department for three years from the date of the recorded event, at the address specified in the license showing for each sealed source and radiation exposure device the following information:

(a) A description (including the make, model and serial number) of each radiation exposure device or transport or storage container in which the sealed source is located:

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

(c) Locations where used and dates of use including the dates removed and returned to storage.

(2) A separately identified utilization log is not required if the equivalent information is available in records of the licensee and available at the address specified in the license.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-110, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-110, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-110, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-110, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-090, filed 12/8/80; Order 1084, § 402-36-090, filed 1/14/76; Order 1, § 402-36-090, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-120 Inspection and maintenance of radiographic exposure devices, transport and storage containers, associated equipment, source changers, and survey instruments. (1) The licensee shall perform visual and operability checks on survey meters, radiographic exposure devices, transport and storage containers, associated equipment and source changers before use on each day the equipment is to be used to ensure that the equipment is in good working condition, that the sources are adequately shielded, and that required labeling is present. Survey instrument operability must be performed using check

sources or other appropriate means. If equipment problems are found, the equipment must be removed from service until repaired.

(2) Each licensee shall have written procedures for:

(a) Inspection and routine maintenance of radiographic exposure devices, source changers, associated equipment, transport and storage containers, and survey instruments at intervals not to exceed three months or before the first use thereafter to ensure the proper functioning of components important to safety. Replacement components shall meet design specifications. If equipment problems are found, the equipment must be removed from service until repaired.

(b) Inspection and maintenance necessary to maintain the Type B packaging used to transport radioactive materials. The 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.

(3) Any maintenance performed on radiographic exposure devices and accessories shall be in accordance with the manufacturer's specifications.

(4) Records of daily checks and quarterly inspections including any equipment problems identified and of any maintenance performed un-

der subsections (1) and (2) of this section shall be made and retained for three years. The record shall include:

- (a) The date of check or inspection;
- (b) Name of inspector;
- (c) Equipment involved;
- (d) Any problems found; and
- (e) What repair or maintenance, if any, was done.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-120, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-120, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-120, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-120, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-120, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-095, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-095, filed 12/8/80; Order 1084, § 402-36-095, filed 1/14/76.]

WAC 246-243-130 Limitations—Personal radiation safety requirements for radiographers and radiographers' assistants. (1) No licensee shall permit any individual to act as a radiographer as defined in this chapter until such individual:

(a) Has been instructed in the subjects outlined in WAC 246-243-230, in addition to a minimum of two months of on-the-job training, and is certified through a radiographer certification program by a certifying entity in accordance with the criteria specified in WAC 246-243-250, Appendix C or equivalent regulations of the United States Nuclear Regulatory Commission or an agreement state. The department maintains a list of recognized certifying entities for reference. The licensee may, until January 1, 2001, allow an individual who has not met the requirement of this subsection, to act as a radiographer after the individual has received training in the subjects outlined in WAC 246-243-230 and demonstrated an understanding of these subjects by successful completion of a written examination that was previously submitted to and approved by the department;

(b) Has received copies of and instruction in the regulations contained in chapters 246-220, 246-221, 246-222, 246-231, and 246-243 WAC, in the United States Department of Transportation regulations as referenced in chapter 246-231 WAC, and the applicable sections of ap-

appropriate license, and the licensee's operating and emergency procedures, and shall have demonstrated understanding thereof by successful completion of a written or oral examination covering this material;

(c) Has received training in the use of 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

(d) Has demonstrated understanding of the use of radiographic exposure devices, sources, survey instruments and associated equipment described in subsection (1)(c) of this section by successful completion of a practical examination on the subjects covered.

(2) No licensee shall permit any individual to act as a radiographer's assistant as defined in this chapter until such individual:

(a) Has received copies of and instruction in the regulations contained in chapters 246-220, 246-221, 246-222, 246-231, and 246-243 WAC, in the United States Department of Transportation regulations as referenced in chapter 246-231 WAC, and the applicable sections of appropriate license, and the licensee's operating and emergency procedures;

(b) Has developed competence to use under the personal supervision of the radiographer the radiographic exposure devices, sealed

sources, associated equipment, and radiation survey instruments which will be employed in the individual's assignment; and

(c) Has demonstrated understanding of the instructions provided under (a) of this subsection by successfully completing a written test on the subjects covered and has demonstrated competence in the use of the hardware described in (b) of this subsection by successful completion of a practical examination on the use of such hardware.

(3) Each licensee shall maintain, for inspection by the department, records of training and certification which demonstrate that the requirements of subsections (1) and (2) of this section are met. These records shall be maintained for three years after the record is made. The record shall include:

(a) Radiographer certification documents and verification of certification status;

(b) Copies of written tests;

(c) Dates of oral and practical examinations; and

(d) Names of individuals conducting and receiving the oral and practical examinations.

(4) Licensees will have until January 1, 2001, to comply with the certification requirements specified in subsection (1)(a) of this sec-

tion, and the additional training requirements specified in subsections (1)(b) and (2)(a) of this section.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-130, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-130, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-130, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-130, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-130, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-100, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-100, filed 12/8/80; Order 1084, § 402-36-100, filed 1/14/76; Order 1, § 402-36-100, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-140 Operating and emergency procedures. The licensee's operating and emergency procedures shall include instructions in at least the following:

(1) The handling and use of sources of radiation to be employed such that no individual is likely to be exposed to radiation doses in

excess of the limits established in chapter 246-221 WAC Standards for protection against radiation;

(2) Methods and occasions for conducting radiation surveys;

(3) Methods for controlling access to radiographic areas;

(4) Methods and occasions for locking and securing sources of radiation including radiographic exposure devices, transport and storage containers, and sealed sources;

(5) Personnel monitoring and the use of personnel monitoring equipment including steps that must be taken immediately by radiography personnel if a pocket dosimeter is found to be off-scale or an alarm rate meter alarms unexpectedly;

(6) Transportation to field locations, including packing of sources of radiation in the vehicles, placarding of vehicles when needed, and control of sources of radiation during transportation;

(7) Minimizing exposure of individuals in the event of an accident;

(8) Notifying proper personnel in the event of a theft, loss, overexposure or accident involving sources of radiation;

(9) Maintenance of records;

(10) The inspection, maintenance, and operability checks of radiographic exposure devices, survey instruments, transport containers, and storage containers;

(11) Identifying and reporting defects and noncompliance as required by these regulations; and

(12) Source recovery procedures if the licensee will perform source recovery.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-140, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-140, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-140, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-140, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-110, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-110, filed 12/8/80; Order 1084, § 402-36-110, filed 1/14/76; Order 708, § 402-36-110, filed 8/24/72; Order 1, § 402-36-110, filed 7/2/71; Order 1, § 402-36-110, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-141 Copies of operating and emergency procedures.

Each licensee shall maintain a copy of current operating and emergency procedures until the department terminates the license. Superseded material shall be retained for three years after the change is approved. [Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-141, filed 3/24/00, effective 4/24/00.]

WAC 246-243-150 Personnel monitoring control. (1) A licensee may not permit any individual to act as a radiographer or as a radiographer's assistant unless, at all times during radiographic operations, the individual wears a direct reading pocket dosimeter, an alarming rate meter, and a personnel dosimeter that is processed and evaluated by an accredited National Voluntary Laboratory Accreditation Program (NVLAP) processor on the trunk of the body. In permanent facilities where other appropriate alarming or warning devices are in routine use, the wearing of an alarming rate meter is not required.

(a) Pocket dosimeters must be capable of measuring exposures from zero to at least 200 milliroentgens. Electronic personal dosimeters may only be used in place of ion-chamber pocket dosimeters.

(b) Each personnel dosimeter shall be assigned to and worn by only one individual.

(c) Film badges must be replaced at periods not to exceed one month and other personnel dosimeters processed and evaluated by an accredited NVLAP processor must be replaced at periods not to exceed three months.

(d) After replacement, each personnel dosimeter must be processed as soon as possible.

(2)(a) Direct reading dosimeters such as pocket dosimeters or electronic personal dosimeters shall be read and exposures recorded at the beginning and end of each shift. Pocket dosimeters shall be charged at the beginning of each shift. Pocket dosimeters shall be checked annually at periods not to exceed twelve months for correct response to radiation. Acceptable dosimeters shall read within plus or minus twenty percent of the true radiation exposure.

(b) Each alarming rate meter must:

(i) Be checked to ensure that the alarm functions properly (sounds) prior to use at the start of each shift;

(ii) Be set to give an alarm signal at a maximum preset rate of 5 mSv/hr. (500 mR/hr.);

(iii) Require special means to change the preset alarm functions;

and

(iv) Be calibrated annually at periods not to exceed twelve months for correct response to radiation: Acceptable rate meters must alarm within plus or minus twenty percent of the true radiation exposure rate.

(3) If an individual's pocket dosimeter is found to be off-scale, or if his or her electronic personal dosimeter reads greater than 2 millisieverts (200 millirems), and the possibility of radiation exposure cannot be ruled out as the cause, the individual's personnel dosimeter must be sent for processing within twenty-four hours. In addition, the individual may not resume work associated with licensed material use until a determination of the individual's radiation exposure has been made. This determination shall be made by the RSO or the RSO's designee.

(4) If the personnel dosimeter required by this section is lost or damaged, the worker shall cease work immediately until a replacement personnel dosimeter is provided and the exposure is calculated for the time period from issuance to loss or damage of the personnel dosimeter.

(5) Each licensee shall maintain the following exposure records:

(a) Direct reading dosimeter readings and yearly operability checks required by subsection (2) of this section for three years after the record is made.

(b) Records of alarm rate meter calibrations for three years after the record is made.

(c) Reports received from the personnel dosimeter accredited NVLAP processor until the department terminates the licensee.

(d) Records of estimates of exposures as a result of: Off-scale personal direct reading dosimeters, or lost or damaged personnel dosimeters, until the department terminates the license. The time period for which the personnel dosimeter was lost or damaged shall be included in the records.

[Statutory Authority: RCW 70.98.050. WSR 03-12-062, § 246-243-150, filed 6/2/03, effective 7/3/03; WSR 00-08-013, § 246-243-150, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-150, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-150, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-150, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-120, filed 9/16/83. Statutory Authority: RCW

70.98.050. WSR 81-01-011 (Order 1570), § 402-36-120, filed 12/8/80; Order 1084, § 402-36-120, filed 1/14/76; Order 1, § 402-36-120, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-160 Supervision of radiographers' assistants. Whenever a radiographer's assistant uses radiographic exposure devices, uses sealed sources or associated equipment, or conducts radiation surveys required by WAC 246-243-190 to determine that the sealed source has returned to the shielded position after an exposure, he or she shall be under the personal supervision of a radiographer, as defined in WAC 246-243-020. Personal supervision shall include (1) the radiographer's personal presence at the site where the sealed sources are being used, (2) the ability of the radiographer to communicate and give immediate assistance if required, and (3) the radiographer's ability to observe the performance of his/her assistant during the operations referred to in this section.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-160, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-160, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-160, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049

(Order 121), recodified as § 246-243-160, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-125, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-125, filed 12/8/80.]

WAC 246-243-170 Security—Precautionary procedures in radiographic operations. (1) During each radiographic operation, the radiographer or radiographer's assistant shall maintain continuous direct visual surveillance of the operation to protect against unauthorized entry into a high radiation area, as defined in chapter 246-220 WAC except:

At permanent radiographic installations where all entryways are locked and the requirements of WAC 246-243-220 are met.

(2) When not in operation or when not under direct surveillance, portable radiation exposure devices shall be physically secured to prevent removal by unauthorized personnel.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-170, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-170, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-170, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049

(Order 121), recodified as § 246-243-170, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-130, filed 12/8/80; Order 1084, § 402-36-130, filed 1/14/76; Order 1, § 402-36-130, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-180 Posting. All areas in which industrial radiography is being performed shall be conspicuously posted as required by WAC 246-221-120. Exceptions listed in WAC 246-221-130 do not apply to industrial radiographic operations.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-180, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-180, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-180, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-180, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-140, filed 12/8/80; Order 1084, § 402-36-140, filed 1/14/76; Order 1, § 402-36-140, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-190 Radiation surveys and survey records. The licensee shall:

(1) Conduct surveys with a calibrated and operable radiation survey instrument that meets the requirements of WAC 246-243-080.

(2) Using a survey instrument meeting the requirements of subsection (1) of this section, conduct a survey of the radiographic exposure device and the guide tube after each exposure when approaching the device or the guide tube. The survey shall determine that the sealed source has returned to its shielded position before exchanging films, repositioning the exposure head, or dismantling equipment.

(3) Conduct a survey of the radiographic exposure device with a calibrated radiation survey instrument any time the source is exchanged and whenever a radiographic exposure device is placed in a storage area to ensure that the sealed source is in its shielded position.

(4) Conduct a physical radiation survey of the boundary of the restricted area during radiographic operations not employing shielded room radiography. The maximum survey reading at the boundary shall be recorded. The records shall indicate approximate distance from source to boundaries, whether or not the exposed source is collimated and any

occupied areas with exposure levels greater than 2 mR in any hour during radiographic operations.

(5) Maintain a record of each exposure device survey conducted before the device is placed in storage if that survey is the last one performed in the workday, and records required by subsection (4) of this section, including the model and serial number of the survey meter used, for inspection by the department for three years after completion of the survey. If the survey was used to determine an individual's exposure, however, the records of the survey shall be maintained until the department authorizes their disposition.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-190, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-190, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 92-06-008 (Order 245), § 246-243-190, filed 2/21/92, effective 3/23/92. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-190, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-150, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-150, filed 12/8/80; Order 1084, § 402-36-150, filed 1/14/76; Order 1, § 402-36-150, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-195 Reporting. (1) In addition to the reporting requirements specified in other sections of the regulations, each licensee shall provide a written report to the department within thirty days of the occurrence of any of the following incidents involving radiographic equipment:

(a) Unintentional disconnection of the source assembly from the control cable.

(b) Inability to retract the source assembly to its fully shielded position and secure it in this position.

(c) Failure of any component (critical to safe operation of the device) to properly perform its intended function.

(2) The licensee shall include the following information in each report submitted under subsection (1) of the section.

(a) A description of the equipment problem;

(b) Cause of each incident, if known;

(c) Manufacturer and model number of equipment involved in the incident;

(d) Place, time, and date of incident;

(e) Actions taken to reestablish normal operations;

(f) Corrective actions taken or planned to prevent recurrence;

(g) Qualifications of personnel involved in the incident.

(3) Reports of overexposure submitted under WAC 246-221-260 which involve failure of safety components of radiographic equipment must also include the information specified in subsection (2) of this section.

(4) Any licensee conducting radiographic operations or storing radioactive material at any location not listed on the license for a period in excess of one hundred eighty days in a calendar year, shall notify the department prior to exceeding the one hundred eighty days.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-195, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-195, filed 12/9/93, effective 1/9/94.]

WAC 246-243-200 Records required at temporary job sites. Each licensee conducting radiographic operations at a temporary site shall have copies of the following documents and records available at that site for inspection by the department:

(1) Appropriate license;

(2) Operating and emergency procedures;

(3) Applicable regulations;

(4) Survey records required pursuant to WAC 246-243-190 for the period of operation at the site;

(5) Direct reading dosimeter records for the period of operation at the site;

(6) The latest radiation survey instrument calibration record and leak test record for specific devices in use at the site;

(7) The latest calibration record for alarm rate meters and operability checks of pocket dosimeters or electronic personal dosimeters as required by WAC 246-243-150;

(8) Utilization records for each radiographic exposure device dispatched from that location as required by WAC 246-243-110;

(9) Records of equipment problems identified in daily checks of equipment as required by WAC 246-243-120;

(10) Records of alarm system and entrance control checks required by WAC 246-243-220, if applicable;

(11) The shipping papers for the transportation of radioactive materials; and

(12) When operating under reciprocity pursuant to WAC 246-232-040, a copy of the NRC or agreement state license authorizing the use of radioactive material.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-200, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-200, filed 3/24/00, effective

4/24/00; WSR 94-01-073, § 246-243-200, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-200, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-200, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-153, filed 12/8/80.]

WAC 246-243-203 Form of records. Each record required by this chapter 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 for producing legible, accurate, and complete records during the required retention period. Records, such as letters, drawings, and specifications, must include all pertinent information, such as stamps, initials, and signatures. The licensee shall maintain adequate safeguards against tampering with and loss of records.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-203, filed 3/24/00, effective 4/24/00.]

WAC 246-243-205 Temporary job site notification. (1) Each licensee shall provide notification to the department as required by the department, preferably twenty-four hours but no later than two hours, prior to beginning radiographic operations at a temporary job site. The notification will be given by using the prescribed 1-800 telephone notification system. The notification shall include:

(a) Name and office telephone number of the licensee;

(b) Radioactive materials license number;

(c) Address or directions to the temporary job site;

(d) Specific dates, times, and duration of expected radiographic operations;

(e) Names of radiographers and, if applicable, radiographer assistants taking part in the radiographic operations; and

(f) Name and telephone number of a contact person at the temporary job site.

(2) In the event that operations at a temporary job site continue for longer than thirty days, the licensee will again notify the de-

partment, as required by subsection (1) of this section, each succeeding month.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-205, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-243-205, filed 12/9/93, effective 1/9/94.]

WAC 246-243-220 Special requirements for permanent radiographic installation. (1) Each entrance that is used for personnel access to the high radiation area in a permanent radiographic installation to which this section applies shall have either:

(a) An entrance control of the type described in WAC 246-221-102(1) that reduces the radiation level upon entry into the area; or

(b) Both conspicuous visible and audible warning signals to warn of the presence of radiation. The visible signal shall be actuated by radiation whenever the source is exposed. The audible signal shall be actuated when an attempt is made to enter the installation while the source is exposed.

(2) 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 (designated in subsection (1)(a) of this section) shall be tested monthly. If an entrance control device or an alarm is operating improperly, it must be immediately labeled as defective and repaired within seven calendar days. The facility may continue to be used during this seven-day period, provided the licensee implements the continuous surveillance requirements of WAC 246-243-170 and uses an alarming rate meter. Test records for entrance controls and audible and visual alarm must be maintained for three years after the record is made.

(3) The department shall review and approve, in advance of construction, plans for permanent radiographic installations whose construction had not commenced by the effective date of these regulations. Construction of the permanent facility shall be in accordance with the plans approved by the department.

(4) A physical radiation survey shall be conducted and results recorded following construction or major modification of the facility to be used in the installation. Radiography shall not be conducted if exposure levels in unrestricted areas are greater than 2 mR in any hour. Any increase in source strength will require resurvey of the installation prior to the conduct of industrial radiography.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-220, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-220, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-15-112 (Order 184), § 246-243-220, filed 7/24/91, effective 8/24/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-220, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-157, filed 9/16/83. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-157, filed 12/8/80.]

WAC 246-243-230 Appendix A—Minimum subjects to be covered in training radiographers. (1) *Fundamentals of radiation safety*

- (a) Characteristics of ionizing radiation
- (b) Units of radiation dose and quantity of radioactivity
- (c) Hazards of exposure to radiation
 - (i) Radiation protection standards
 - (ii) Biological effects of radiation dose
- (d) Levels of radiation from sources of radiation
- (e) Methods of controlling radiation dose
 - (i) Working time
 - (ii) Working distances

(iii) Shielding

(2) *Radiation detection instrumentation to be used*

(a) Use of radiation survey instruments

(i) Operation

(ii) Calibration

(iii) Limitations

(b) Survey techniques

(c) Use of personnel monitoring equipment

(i) Film badges

(ii) Pocket dosimeters

(iii) Thermoluminescent dosimeters

(iv) Alarming rate meters

(3) *Radiographic equipment to be used*

(a) Operation and control of remote handling equipment, radiographic exposure equipment, and storage containers, including pictures or models of source assemblies (pigtailed)

(b) Inspection and maintenance of equipment

(c) Storage, control, and disposal of licensed material

(4) *The requirements of pertinent federal and state regulations*

(5) *The licensee's written operating and emergency procedures*

(6) *Case histories of radiography accidents.*

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-243-230, filed 3/24/00, effective 4/24/00; WSR 94-01-073, § 246-243-230, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-230, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.050. WSR 81-01-011 (Order 1570), § 402-36-160, filed 12/8/80; Order 1084, § 402-36-160, filed 1/14/76; Order 1, § 402-36-160, filed 1/8/69; Rules (part), filed 10/26/66.]

WAC 246-243-240 Appendix B—General guidelines for inspection of radiography equipment. (1) Panoramic devices (devices in which the source is physically removed from shielded container during exposure) should be inspected for:

- (a) Radiographic exposure unit;
 - (i) Abnormal surface radiation levels anywhere on camera;
 - (ii) Condition of safety plugs;
 - (iii) Proper operation of locking mechanism;
 - (iv) Condition of pigtail connector;
 - (v) Alignment of "S" tube with exit port;
 - (vi) Condition of carrying device (for example, straps and handles);

(vii) Proper labeling;

(b) Source tube;

(i) Rust, corrosion, dirt, or sludge buildup inside the source tube;

(ii) Condition of source tube connector;

(iii) Condition of source stop;

(iv) Kinks or damage that could prevent proper operation;

(c) Control cables and drive mechanism;

(i) Proper drive mechanism for this camera, if appropriate;

(ii) Changes in general operating characteristics;

(iii) Condition of connector on drive cable;

(iv) Drive cable flexibility, wear, and rust;

(v) Excessive wear or damage to crank assembly parts;

(vi) Damage to drive cable conduit that could prevent the cable from moving freely;

(vii) Connection of the control cable connector with the pigtail connector for proper mating;

(viii) Proper operation of source position indicator, if applicable.

(2) Directional beam devices should be inspected for:

(a) Abnormal surface radiation;

- (b) Changes in the general operating characteristics of the unit;
- (c) Proper operation of shutter mechanism;
- (d) Chafing or binding of shutter mechanism;
- (e) Damage to the device which might impair its operation;
- (f) Proper operation of locking mechanism;
- (g) Proper drive mechanism with this camera, if appropriate;
- (h) Condition of carrying device (for example, straps and handles);
- (i) Proper labeling.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-240, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 94-01-073, § 246-243-240, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-243-240, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 83-19-050 (Order 2026), § 402-36-165, filed 9/16/83.]

WAC 246-243-250 Appendix C—Radiographer certification. (1) Requirements for an independent certifying organization. An independent certifying organization shall:

(a) Be an organization such as a society or association, whose members participate in, or have an interest in, the fields of industrial radiography;

(b) Make its membership available to the general public nationwide that is not restricted because of race, color, religion, sex, age, national origin or disability;

(c) Have a certification program open to nonmembers, as well as members;

(d) Be an incorporated, nationally recognized organization that is involved in setting national standards of practice within its fields of expertise;

(e) Have an adequate staff, a viable system for financing its operations, and a policy- and decision-making review board;

(f) 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;

(g) 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.

(h) Have a committee, whose members can carry out their responsibilities impartially, to review complaints against certified individuals and to determine appropriate sanctions;

(i) 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;

(j) 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;

(k) 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;

(l) Exchange information about certified individuals with the department, the US Nuclear Regulatory Commission, other independent certifying organizations or agreement states and allow periodic review of its certification program and related records; and

(m) Provide a description to the department of its procedures for choosing examination sites and for providing an appropriate examination environment.

(2) Requirements for certification programs. All certification programs must:

(a) Require applicants for certification to:

(i) Receive training in the topics set forth in WAC 246-243-230 or equivalent NRC or agreement state regulations; and

(ii) Satisfactorily complete a written examination covering these topics;

(b) Require applicants for certification to provide documentation that demonstrates that the applicant has:

(i) Received training in the topics set forth in WAC 246-243-230 or equivalent NRC or agreement state regulations;

(ii) Satisfactorily completed a minimum period of on-the-job training; and

(iii) Received verification by an agreement state or a NRC licensee that the applicant has demonstrated the capability of independently working as a radiographer;

(c) Include procedures to ensure that all examination questions are protected from disclosure;

(d) Include procedures for denying an application, revoking, suspending, and reinstating a certificate;

(e) Provide a certification period of not less than three years nor more than five years;

(f) Include procedures for renewing certifications and, if the procedures allow renewals without examination, require evidence of recent full-time employment and annual refresher training;

(g) Provide a timely response to inquiries, by telephone or letter, from members of the public, about an individual's certification status.

(3) Requirements for written examinations.

All examinations must be:

(a) Designed to test an individual's knowledge and understanding of the topics listed in WAC 246-243-230 or equivalent NRC or agreement state requirements;

(b) Written in a multiple-choice format;

(c) Have test items drawn from a question bank containing psychometrically valid questions based on the material in WAC 246-243-230.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 16-13-054, § 246-243-250, filed 6/10/16, effective 7/11/16. Statutory Authority:

RCW 70.98.050. WSR 00-08-013, § 246-243-250, filed 3/24/00, effective
4/24/00.]

Chapter 246-252 WAC

RADIATION PROTECTION—URANIUM OR THORIUM MILLING

Last Update: 12/12/16

WAC

- 246-252-001 Reclamation and decommissioning.
- 246-252-010 Definitions, abbreviations, and acronyms.
- 246-252-020 Purpose of uranium mill tailings areas.
- 246-252-030 Criteria related to disposition of uranium mill tailings or wastes.
- 246-252-040 Continuing dose assessment.
- 246-252-050 Appendix A.

WAC 246-252-001 Reclamation and decommissioning. A specific plan for reclamation and disposal of tailings and for decommissioning the site of uranium or thorium milling operations shall be included as part of the proposed action assessed under SEPA regulations and guidelines as required by WAC 246-235-086(1) for licensing of environmentally significant operations. For any uranium or thorium mill in operation on or before the effective date of this regulation for which a plan for reclamation and disposal of tailings and decommissioning of the site has not been submitted and assessed, such a plan must be sub-

mitted to the department and a final environmental impact statement or final declaration of nonsignificance must accompany or precede the license renewal.

[Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-252-001, filed 3/24/00, effective 4/24/00. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-16-109 (Order 187), § 246-252-001, filed 8/7/91, effective 9/7/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-252-001, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 79-12-073 (Order 1459), § 402-52-005, filed 11/30/79, effective 1/1/80.]

WAC 246-252-010 Definitions, abbreviations, and acronyms. The definitions, abbreviations, and acronyms in this section and in WAC 246-220-010 apply throughout this chapter unless the context clearly indicates otherwise.

(1) **"Aquifer"** means a geologic formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs. Any saturated zone created by uranium or thorium recovery operations would not be considered an aquifer unless the zone is, or potentially is (a) hydraulically interconnected to a natural aquifer, (b) capable of discharge to surface water, or

(c) reasonably accessible because of migration beyond the vertical projection of the boundary of the land transferred to long-term government ownership and care in accordance with WAC 246-252-030(11).

(2) **"As expeditiously as practicable considering technological feasibility,"** for the purposes of Criterion 6A, means as quickly as possible considering: The physical characteristics of the tailings and the site; the limits of available technology; the need for consistency with mandatory requirements of other regulatory programs; and factors beyond the control of the licensee. The phrase permits consideration of the cost of compliance only to the extent specifically provided for by use of the term "available technology."

(3) **"Available technology"** means technologies and methods for emplacing a final radon barrier on uranium mill tailings piles or impoundments. This term shall not be construed to include extraordinary measures or techniques that would impose costs that are grossly excessive as measured by practice within the industry (or one that is reasonably analogous), (such as, by way of illustration only, unreasonable overtime, staffing, or transportation requirements, considering normal practice in the industry; laser fusion of soils), provided there is reasonable progress toward emplacement of the final radon barrier. To determine grossly excessive costs, the relevant baseline

against which cost shall be compared is the cost estimate for tailings impoundment closure contained in the licensee's approved reclamation plan, but costs beyond these estimates shall not automatically be considered grossly excessive.

(4) **"Closure"** means the activities following operations to decontaminate and decommission the buildings and site used to produce by-product materials and reclaim the tailings or waste disposal area.

(5) **"Closure plan"** means the department approved plan to accomplish closure.

(6) **"Compliance period"** begins when the department sets secondary groundwater protection standards and ends when the owner or operator's license is terminated and the site is transferred to the state or federal agency for long-term care.

(7) **"Dike"** means an embankment or ridge of either natural or man-made materials used to prevent the movement of liquids, sludges, solids, or other materials.

(8) **"Disposal area"** means the area containing by-product materials to which the requirements of Criterion 6 apply.

(9) **"Existing portion"** means that land surface area of an existing surface impoundment on which significant quantities of uranium or

thorium by-product materials had been placed prior to September 30, 1983.

(10) **"Factors beyond the control of the licensee"** means factors proximately causing delay in meeting the schedule in the applicable reclamation plan for the timely emplacement of the final radon barrier notwithstanding the good faith efforts of the licensee to complete the barrier in compliance with paragraph (a) of Criterion 6A. These factors may include, but are not limited to:

(a) Physical conditions at the site;

(b) Inclement weather or climatic conditions;

(c) An act of God;

(d) An act of war;

(e) A judicial or administrative order or decision, or change to the statutory, regulatory, or other legal requirements applicable to the licensee's facility that would preclude or delay the performance of activities required for compliance;

(f) Labor disturbances;

(g) Any modifications, cessation or delay ordered by state, federal, or local agencies;

(h) Delays beyond the time reasonably required in obtaining necessary government permits, licenses, approvals, or consent for activi-

ties described in the reclamation plan proposed by the licensee that result from agency failure to take final action after the licensee has made a good faith, timely effort to submit legally sufficient applications, responses to requests (including relevant data requested by the agencies), or other information, including approval of the reclamation plan; and

(i) An act or omission of any third party over whom the licensee has no control.

(11) "**Final radon barrier**" means the earthen cover (or approved alternative cover) over tailings or waste constructed to comply with Criterion 6 of WAC 246-252-030 (excluding erosion protection features).

(12) "**Groundwater**" means water below the land surface in a zone of saturation. For the purposes of this chapter, groundwater is the water contained within an aquifer as defined above.

(13) "**Leachate**" means any liquid, including any suspended or dissolved components in the liquid, that has percolated through or drained from the by-product material.

(14) "**Licensed site**" means the area contained within the boundary of a location under the control of persons generating or storing by-product materials under a department license.

(15) **"Liner"** means a continuous layer of natural or man-made materials, beneath or on the sides of a surface impoundment which restricts the downward or lateral escape of by-product material, hazardous constituents, or leachate.

(16) **"Milestone"** means an action or event that is required to occur by an enforceable date.

(17) **"Operation"** means that a uranium or thorium mill tailings pile or impoundment is being used for the continued placement of by-product material or is in standby status for such placement. A pile or impoundment is in operation from the day that by-product material is first placed in the pile or impoundment until the day final closure begins.

(18) **"Point of compliance"** is the site specific location in the uppermost aquifer where the groundwater protection standard must be met.

(19) **"Reclamation plan,"** for the purposes of Criterion 6A, means the plan detailing activities to accomplish reclamation of the tailings or waste disposal area in accordance with the technical criteria of WAC 246-252-030. The reclamation plan must include a schedule for reclamation milestones that are key to the completion of the final radon barrier including as appropriate, but not limited to, wind blown

tailings retrieval and placement on the pile, interim stabilization (including dewatering or the removal of freestanding liquids and re-contouring), and final radon barrier construction. (Reclamation of tailings must also be addressed in the closure plan; the detailed reclamation plan may be incorporated into the closure plan.)

(20) **"Surface impoundment"** means a natural topographic depression, man-made excavation, or diked area, which is designed to hold an accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well.

(21) **"Uppermost aquifer"** means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary.

[Statutory Authority: RCW 70.98.050. WSR 15-06-015, § 246-252-010, filed 2/23/15, effective 3/26/15; WSR 97-13-055, § 246-252-010, filed 6/16/97, effective 7/17/97. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-16-109 (Order 187), § 246-252-010, filed 8/7/91, effective 9/7/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-252-010, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-52-050, filed 12/11/86.]

WAC 246-252-020 Purpose of uranium mill tailings areas. Uranium mill tailing areas shall be used only for disposal of radioactive wastes originating from the exploration, mining, and milling of uranium.

[Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-252-020, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080 and chapter 70.121 RCW. WSR 86-17-027 (Order 2406), § 402-52-090, filed 8/13/86.]

WAC 246-252-030 Criteria related to disposition of uranium mill tailings or wastes. As used in this section, the term "by-product material" means the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

As required by WAC 246-235-110(6), each applicant for a license to possess and use source material in conjunction with uranium or thorium milling, or by-product material at sites formerly associated with such milling, is required to include in a license application proposed specifications relating to the milling operation and the disposition of tailings or waste resulting from such milling activities. This section establishes criteria relating to the siting, operation, decontam-

ination, decommissioning, and reclamation of mills and tailings or waste systems and sites at which such mills and systems are located and site and by-product material ownership. Applications must clearly demonstrate how these criteria have been addressed. The specifications shall be developed considering the expected full capacity of tailings or waste systems and the lifetime of mill operations. Where later expansions of systems or operations may be likely, the amenability of the disposal system to accommodate increased capacities without degradation in long-term stability and other performance factors shall be evaluated.

Licensees or applicants may propose alternatives to the specific requirements in these criteria. The alternative proposals may take into account local or regional conditions, including geology, topography, hydrology, and meteorology. The department may find that the proposed alternatives meet the department's requirements if the alternatives will achieve a level of stabilization and containment of the sites concerned, and a level of protection for public health, safety, and the environment from radiological and nonradiological hazards associated with the sites, which is equivalent to, to the extent practicable, or more stringent than the level which would be achieved by the

requirements of the standards promulgated by the United States Environmental Protection Agency in 40 C.F.R. 192, Subparts D and E.

(1) Criterion 1 - In selecting among alternative tailings disposal sites or judging the adequacy of existing tailings sites, the following site features which would contribute to meeting the broad objective of permanent isolation of the tailings and associated contaminants from man and the environment for one thousand years to the extent reasonably achievable, and in any case, for at least two hundred years without ongoing active maintenance shall be considered:

(a) Remoteness from populated areas;

(b) Hydrogeologic and other environmental conditions conducive to continued immobilization and isolation of contaminants from groundwater sources; and

(c) Potential for minimizing erosion, disturbance, and dispersion by natural forces over the long term.

The site selection process must be an optimization to the maximum extent reasonably achievable in terms of these features.

In the selection of disposal sites, primary emphasis shall be given to isolation of tailings or wastes, a matter having long-term impacts, as opposed to consideration only of short-term convenience or benefits, such as minimization of transportation or land acquisition

costs. While isolation of tailings will be a function of both site characteristics and engineering design, overriding consideration shall be given to siting features given the long-term nature of the tailings hazards.

Tailings shall be disposed in a manner such that no active maintenance is required to preserve the condition of the site.

(2) Criterion 2 - To avoid proliferation of small waste disposal sites, by-product material from in-situ extraction operations, such as residues from solution evaporation or contaminated control processes, and wastes from small remote above ground extraction operations shall be disposed at existing large mill tailings disposal sites; unless, considering the nature of the wastes, such as their volume and specific activity and the costs and environmental impacts of transporting the wastes to a large disposal site, such off-site disposal is demonstrated to be impracticable or the advantage of on-site burial clearly outweighs the benefits of reducing the perpetual surveillance obligations.

(3) Criterion 3 - The "prime option" for disposal of tailings is placement below grade, either in mines or specially excavated pits (that is, where the need for any specially constructed retention structure is eliminated).

The evaluation of alternative sites and disposal methods performed by mill operators in support of their proposed tailings disposal program (provided in applicants' environmental reports) shall reflect serious consideration of this disposal mode. In some instances, below grade disposal may not be the most environmentally sound approach, such as might be the case if a groundwater formation is relatively close to the surface or not very well isolated by overlying soils and rock. Also, geologic and topographic conditions might make full, below grade burial impracticable; for example, near-surface bedrock could create prominent excavation costs while more suitable alternate sites may be available. Where full below grade burial is not practicable, the size of the retention structures, and the size and steepness of slopes of associated exposed embankments, shall be minimized by excavation to the maximum extent reasonably achievable or appropriate, given the geologic and hydrogeologic conditions at a site. In these cases, it must be demonstrated that an above-grade disposal program will provide reasonably equivalent isolation of the tailings from natural erosional forces.

(4) Criterion 4 - The following site and design criteria shall be adhered to whether tailings or wastes are disposed of above or below grade:

(a) Upstream rainfall catchment areas must be minimized to decrease erosion potential and the size of the probable maximum flood which could erode or wash out sections of the tailings disposal area.

(b) Topographic features shall provide good wind protection.

(c) Embankment and cover slopes shall be relatively flat after final stabilization to minimize erosion potential and to provide conservative factors of safety assuring long-term stability. The broad objective should be to contour final slopes to grades which are as close as possible to those which would be provided if tailings were disposed of below grade; this could, for example, lead to slopes of about ten horizontal to one vertical (10h:1v) or less steep. In general, slopes should not be steeper than about 5h:1v. Where steeper slopes are proposed, reasons why a slope less steep than 5h:1v would be impracticable should be provided, and compensating factors and conditions which make such slopes acceptable should be identified.

(d) A fully self-sustaining vegetative cover shall be established or rock cover employed to reduce wind and water erosion to negligible levels.

Where a full vegetative cover is not likely to be self-sustaining due to climatic conditions, such as in semi-arid and arid regions, rock cover shall be employed on slopes of the impoundment system. The

NRC will consider relaxing this requirement for extremely gentle slopes such as those which may exist on the top of the pile.

The following factors shall be considered in establishing the final rock cover design to avoid displacement of rock particles by human and animal traffic or by natural processes, and to preclude undercutting and piping:

(i) Shape, size, composition, gradation of rock particles (excepting bedding material, average particle size shall be at least cobble size or greater);

(ii) Rock cover thickness and zoning of particles by size; and

(iii) Steepness of underlying slopes.

(e) Individual rock fragments must be dense, sound, and resistant to abrasion, and free from defects that would tend to unduly increase their destruction by water and frost actions. Weak, friable, or laminated aggregate may not be used. Shale, rock laminated with shale, and cherts may not be used.

Rock covering of slopes may be unnecessary where top covers are very thick (on the order of ten meters or greater); impoundment slopes are very gentle (on the order of 10h:1v or less); bulk cover materials have inherently favorable erosion resistance characteristics; and there is negligible drainage catchment area upstream of the pile, and

good wind protection as described in (a) and (b) of this subsection (Criterion 4).

(f) Impoundment surfaces shall be contoured to avoid areas of concentrated surface runoff or abrupt or sharp changes in slope gradient. In addition to rock cover on slopes, areas toward which surface runoff might be directed shall be well protected with substantial rock cover (riprap). In addition to providing for stability of the impoundment systems itself, the overall stability, erosion potential, and geomorphology of surrounding terrain shall be evaluated to assure that there are no processes, such as gully erosion, which would lead to impoundment instability.

(g) The impoundment may not be located near a capable fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand. As used in this criterion, the term "capable fault" has the same meaning as defined in Section III (g) of Appendix A of 10 C.F.R. Part 100. The term "maximum credible earthquake" means that earthquake which would cause the maximum vibratory ground motion based upon an evaluation of earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material.

(h) The impoundment, where feasible, should be designed to incorporate features which will promote deposition of suspended particles. For example, design features which promote deposition of sediment suspended in any runoff which flows into the impoundment area might be utilized; the object of such a design feature would be to enhance the thickness of cover over time.

(5) Criterion 5 - Criteria 5(a) through 5(g) and new Criterion 13 incorporate the basic groundwater protection standards imposed by the United States Environmental Protection Agency in 40 C.F.R. Part 192, Subparts D and E (48 FR 45926; October 7, 1983) which apply during operations and prior to the end of closure. Groundwater monitoring to comply with these standards is required by Criterion 7.

(a) The primary groundwater protection standard is a design standard for surface impoundments used to manage uranium and thorium by-product material. Surface impoundments (except for an existing portion) must have a liner that is designed, constructed, and installed to prevent any migration of wastes out of the impoundment to the adjacent subsurface soil, groundwater, or surface water at any time during the active life (including the closure period) of the impoundment. The liner may be constructed of materials that may allow wastes to migrate into the liner (but not into the adjacent subsurface soil, groundwa-

ter, or surface water) during the active life of the facility, provided that impoundment closure includes removal or decontamination of all waste residues, contaminated containment system components (liners), contaminated subsoils, and structures and equipment contaminated with waste and leachate. For impoundments that will be closed with the liner material left in place, the liner must be constructed of materials that can prevent wastes from migrating into the liner during the active life of the facility.

(b) The liner required by (a) of this subsection must be:

(i) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the waste or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;

(ii) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

(iii) Installed to cover all surrounding earth likely to be in contact with the wastes or leachate.

(c) The applicant or licensee will be exempted from the requirements of (a) of this subsection if the department finds, based on a demonstration by the applicant or licensee, that alternate design and operating practices, including the closure plan, together with site characteristics will prevent the migration of any hazardous constituents into groundwater or surface water at any future time. In deciding whether to grant an exemption, the department will consider:

(i) The nature and quantity of the wastes;

(ii) The proposed alternate design and operation;

(iii) The hydrogeologic setting of the facility, including the attenuation capacity and thickness of the liners and soils present between the impoundment and groundwater or surface water; and

(iv) All other factors which would influence the quality and mobility of the leachate produced and the potential for it to migrate to groundwater or surface water.

(d) A surface impoundment must be designed, constructed, maintained, and operated to prevent overtopping resulting from normal or abnormal operations; overfilling; wind and wave actions; rainfall; run-on; from malfunctions of level controllers, alarms, and other equipment; and human error.

(e) When dikes are used to form the surface impoundment, the dikes must be designed, constructed, and maintained with sufficient structural integrity to prevent massive failure of the dikes. In ensuring structural integrity, it must not be presumed that the liner system will function without leakage during the active life of the impoundment.

(f) Uranium and thorium by-product materials must be managed to conform to the following secondary groundwater protection standard: Hazardous constituents entering the groundwater from a licensed site must not exceed the specified concentration limits in the uppermost aquifer beyond the point of compliance during the compliance period. Hazardous constituents are those constituents identified by the department pursuant to (g) of this subsection. Specified concentration limits are those limits established by the department as indicated in (j) of this subsection. The department will also establish the point of compliance and compliance period on a site specific basis through license conditions and orders. The objective in selecting the point of compliance is to provide the earliest practicable warning that the impoundment is releasing hazardous constituents to the groundwater. The point of compliance must be selected to provide prompt indication of groundwater contamination on the hydraulically downgradient edge of

the disposal area. The department must identify hazardous constituents, establish concentration limits, set the compliance period, and adjust the point of compliance, if needed, when the detection monitoring established under criterion 7 indicates leakage of hazardous constituents from the disposal area.

(g) A constituent becomes a hazardous constituent subject to (j) of this subsection when the constituent:

(i) Is reasonably expected to be in or derived from the by-product material in the disposal area;

(ii) Has been detected in the groundwater in the uppermost aquifer; and

(iii) Is listed in WAC 246-252-050 Appendix A.

(h) The department may exclude a detected constituent from the set of hazardous constituents on a site specific basis if it finds that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment. In deciding whether to exclude constituents, the department will consider the following:

(i) Potential adverse effect on groundwater quality, considering:

(A) The physical and chemical characteristics of the waste in the licensed site, including its potential for migration;

(B) The hydrogeological characteristics of the facility and surrounding land;

(C) The quantity of groundwater and the direction of groundwater flow;

(D) The proximity and withdrawal rates of groundwater users;

(E) The current and future uses of groundwater in the area;

(F) The existing quality of groundwater, including other sources of contamination and their cumulative impact on the groundwater quality;

(G) The potential for health risks caused by human exposure to waste constituents;

(H) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents;

(I) The persistence and permanence of the potential adverse effects.

(ii) Potential adverse effects on hydraulically connected surface water quality, considering:

(A) The volume and physical and chemical characteristics of the waste in the licensed site;

(B) The hydrogeological characteristics of the facility and surrounding land;

(C) The quantity and quality of groundwater, and the direction of groundwater flow;

(D) The patterns of rainfall in the region;

(E) The proximity of the licensed site to surface waters;

(F) The current and future uses of surface waters in the area and any water quality standards established for those surface waters;

(G) The existing quality of surface water, including other sources of contamination and the cumulative impact on surface water quality;

(H) The potential for health risks caused by human exposure to waste constituents;

(I) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and

(J) The persistence and permanence of the potential adverse effects.

(i) In making any determinations under (h) and (k) of this subsection about the use of groundwater in the area around the facility, the department will consider any identification of underground sources of drinking water and exempted aquifers made by the United States Environmental Protection Agency.

(j) At the point of compliance, the concentration of a hazardous constituent must not exceed:

(i) The department approved background concentration of that constituent in the groundwater;

(ii) The respective value given in the table in subsection (5)(1) of this section if the constituent is listed in the table and if the background level of the constituent is below the value listed; or

(iii) An alternate concentration limit established by the department.

(k) Conceptually, background concentrations pose no incremental hazards and the drinking water limits in (j)(i) of this subsection state acceptable hazards but these two options may not be practically achievable at a specific site. Alternate concentration limits that present no significant hazard may be proposed by licensees for department consideration. Licensees must provide the basis for any proposed limits including consideration of practicable corrective actions, that limits are as low as reasonably achievable, and information on the factors the department must consider.

The department will establish a site specific alternate concentration limit for a hazardous constituent as provided in (j) of this subsection if it finds that the constituent will not pose a substan-

tial present or potential hazard to human health or the environment as long as the alternate concentration limit is not exceeded. In establishing alternate concentration limits, the department will apply its as low as reasonably achievable criterion in this chapter. The department will also consider the following factors:

(i) Potential adverse effects on groundwater quality, considering:

(A) The physical and chemical characteristics of the waste in the licensed site including its potential for migration;

(B) The hydrogeological characteristics of the facility and surrounding land;

(C) The quantity of groundwater and the direction of groundwater flow;

(D) The proximity and withdrawal rates of groundwater users;

(E) The current and future uses of groundwater in the area;

(F) The existing quality of groundwater, including other sources of contamination and their cumulative impact on the groundwater quality;

(G) The potential for health risks caused by human exposure to waste constituents;

(H) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents;

(I) The persistence and permanence of the potential adverse effects.

(ii) Potential adverse effects on hydraulically connected surface water quality, considering:

(A) The volume and physical and chemical characteristics of the waste in the licensed site;

(B) The hydrogeological characteristics of the facility and surrounding land;

(C) The quantity and quality of groundwater, and the direction of groundwater flow;

(D) The patterns of rainfall in the region;

(E) The proximity of the licensed site to surface waters;

(F) The current and future uses of surface waters in the area and any water quality standards established for those surface waters;

(G) The existing quality of surface water including other sources of contamination and the cumulative impact on surface water quality;

(H) The potential for health risks caused by human exposure to waste constituents;

(I) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and

(J) The persistence and permanence of the potential adverse effects.

(1) MAXIMUM VALUES FOR GROUNDWATER PROTECTION:

Constituent or Property	Maximum Concentration
	Milligrams per liter
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05
Endrin (1,2,3,4,10,10-hexachloro-1,7 -epoxy-1,4,4a,5,6,7,8,9a-octahydro-1, 4-endo, endo-5,8-dimethano naphthalene)	0.0002
Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer)	0.004
Methoxychlor (1,1,1-Trichloro-2,2-bis(p-methoxyphenylethane)	0.1
Toxaphene (C ₁₀ H ₁₀ Cl ₆ , Technical chlorinated camphene, 67-69 percent chlorine)	0.005
2,4-D (2,4-Dichlorophenoxyacetic acid)	0.1
2,4,5-TP Silvex (2,4,5-Trichlorophenoxypropionic acid)	0.01
	Picocuries per liter
Combined radium - 226 and radium - 228	5
Gross alpha - particle activity (excluding radon and uranium when producing uranium by-product material or thorium when producing thorium by-product material)	15

(m) If the groundwater protection standards established under (f) of this subsection are exceeded at a licensed site, a corrective action program must be put into operation as soon as is practicable, and in no event later than eighteen months after the department finds that the standards have been exceeded. The licensee shall submit the pro-

posed corrective action program and supporting rationale for department approval prior to putting the program into operation, unless otherwise directed by the department. The objective of the program is to return hazardous constituent concentration levels in groundwater to the concentration limits set as standards. The licensee's proposed program must address removing the hazardous constituents that have entered the groundwater at the point of compliance or treating them in place. The program must also address removing or treating in place any hazardous constituents that exceed concentration limits in groundwater between the point of compliance and the downgradient facility property boundary. The licensee shall continue corrective action measures to the extent necessary to achieve and maintain compliance with the groundwater protection standard. The department will determine when the licensee may terminate corrective action measures based on data from the groundwater monitoring program and other information that provide reasonable assurance that the groundwater protection standard will not be exceeded.

(n) In developing and conducting groundwater protection programs, applicants and licensees shall also consider the following:

(i) Installation of bottom liners (where synthetic liners are used, a leakage detection system must be installed immediately below

the liner to ensure major failures are detected if they occur. This is in addition to the groundwater monitoring program conducted as provided in Criterion 7. Where clay liners are proposed or relatively thin, in-situ clay soils are to be relied upon for seepage control, tests must be conducted with representative tailings solutions and clay materials to confirm that no significant deterioration of permeability or stability properties will occur with continuous exposure of clay to tailings solutions. Tests must be run for a sufficient period of time to reveal any effects if they are going to occur (in some cases deterioration has been observed to occur rather rapidly after about nine months of exposure)).

(ii) Mill process designs which provide the maximum practicable recycle of solutions and conservation of water to reduce the net input of liquid to the tailings impoundment.

(iii) Dewatering of tailings by process devices or in-situ drainage systems (at new sites, tailings must be dewatered by a drainage system installed at the bottom of the impoundment to lower the phreatic surface and reduce the driving head of seepage, unless tests show tailings are not amenable to such a system. Where in-situ dewatering is to be conducted, the impoundment bottom must be graded to assure that the drains are at a low point. The drains must be protected by

suitable filter materials to assure that drains remain free running. The drainage system must also be adequately sized to assure good drainage).

(iv) Neutralization to promote immobilization of hazardous constituents.

(o) Where groundwater impacts are occurring at an existing site due to seepage, action must be taken to alleviate conditions that lead to excessive seepage impacts and restore groundwater quality. The specific seepage control and groundwater protection method, or combination of methods, to be used must be worked out on a site-specific basis. Technical specifications must be prepared to control installation of seepage control systems. A quality assurance, testing, and inspection program, which includes supervision by a qualified engineer or scientist, must be established to assure the specifications are met.

(p) In support of a tailings disposal system proposal, the applicant/operator shall supply information concerning the following:

(i) The chemical and radioactive characteristics of the waste solutions.

(ii) The characteristics of the underlying soil and geologic formations particularly as they will control transport of contaminants and solutions. This includes detailed information concerning extent,

thickness, uniformity, shape, and orientation of underlying strata. Hydraulic gradients and conductivities of the various formations must be determined. This information must be gathered from borings and field survey methods taken within the proposed impoundment area and in surrounding areas where contaminants might migrate to groundwater. The information gathered on boreholes must include both geologic and geophysical logs in sufficient number and degree of sophistication to allow determining significant discontinuities, fractures, and channeled deposits of high hydraulic conductivity. If field survey methods are used, they should be in addition to and calibrated with borehole logging. Hydrologic parameters such as permeability may not be determined on the basis of laboratory analysis of samples alone; a sufficient amount of field testing (e.g., pump tests) must be conducted to assure actual field properties are adequately understood. Testing must be conducted to allow estimating chemi-sorption attenuation properties of underlying soil and rock.

(iii) Location, extent, quality, capacity and current uses of any groundwater at and near the site.

(q) Steps must be taken during stockpiling of ore to minimize penetration of radionuclides into underlying soils; suitable methods include lining or compaction of ore storage areas.

(6) Criterion 6 - (a) In disposing of waste by-product material, licensees shall place an earthen cover (or approved alternative) over tailings or wastes at the end of milling operations and shall close the waste disposal area in accordance with a design¹ which provides reasonable assurance of control of radiological hazards to:

(i) Be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years; and

(ii) Limit releases of Radon-222 from uranium by-product materials, and Radon-220 from thorium by-product materials, to the atmosphere so as not to exceed an average² release rate of 20 picocuries per square meter per second (pCi/m²s) to the extent practicable throughout the effective design life determined pursuant to (a)(i) of this subsection (this criterion). In computing required tailings cover thicknesses, moisture in soils in excess of amounts found normally in similar soils in similar circumstances may not be considered. Direct gamma exposure from the tailings or wastes should be reduced to background levels. The effects of any thin synthetic layer may not be taken into account in determining the calculated radon exhalation level. If non-soil materials are proposed as cover materials, it must be demonstrated that these materials will not crack or degrade by differential settlement, weathering, or other mechanism, over long-term intervals.

(b) As soon as reasonably achievable after emplacement of the final cover to limit releases of Radon-222 from uranium by-product material and prior to placement of erosion protection barriers or other features necessary for long-term control of the tailings, the licensee shall verify through appropriate testing and analysis that the design and construction of the final radon barrier is effective in limiting releases of Radon-222 to a level not exceeding 20 pCi/m²s averaged over the entire pile or impoundment using the procedures described in 40 C.F.R. part 61, appendix B, Method 115, or another method of verification approved by NRC as being at least as effective in demonstrating the effectiveness of the final radon barrier.

(c) When phased emplacement of the final radon barrier is included in the applicable reclamation plan, the verification of Radon-222 release rates required in (b) of this subsection (this criterion) must be conducted for each portion of the pile or impoundment as the final radon barrier for that portion is emplaced.

(d) Within ninety days of the completion of all testing and analysis relevant to the required verification in (b) and (c) of this subsection (this criterion), the uranium mill licensee shall report to the department the results detailing the actions taken to verify that levels of release of Radon-222 do not exceed 20 pCi/m²s when averaged

over the entire pile or impoundment. The licensee shall maintain records until termination of the license documenting the source of input parameters including the results of all measurements on which they are based, the calculations or analytical methods used to derive values for input parameters, and the procedure used to determine compliance. These records shall be kept in a form suitable for transfer to the custodial agency at the time of transfer of the site to DOE or a state for long-term care if requested.

(e) Near surface cover materials (i.e., within the top three meters) may not include waste or rock that contains elevated levels of radium; soils used for near surface cover must be essentially the same, as far as radioactivity is concerned, as that of surrounding surface soils. This is to ensure that surface radon exhalation is not significantly above background because of the cover material itself.

(f) The design requirements in this criterion for longevity and control of radon releases apply to any portion of a licensed or disposal site unless such portion contains a concentration of radium in land, averaged over areas of 100 square meters, which, as a result of by-product material, does not exceed the background level by more than:

(i) 5 picocuries per gram (pCi/g) of radium-226, or, in the case of thorium by-product material, radium-228, averaged over the first 15 centimeters (cm) below the surface; and

(ii) 15 pCi/g of radium-226, or, in the case of thorium by-product material, radium-228, averaged over 15-cm thick layers more than 15 cm below the surface.

(g) By-product material containing concentrations of radionuclides other than radium in soil, and surface activity on remaining structures, must not result in a total effective dose equivalent (TEDE) exceeding the dose from cleanup of radium contaminated soil to the standard (benchmark dose) contained in (f) of this subsection, and must be at levels which are as low as is reasonably achievable (ALARA). If more than one residual radionuclide is present in the same 100 square meter area, the sum of the ratios for each radionuclide of concentration present to the concentration limit will not exceed "1" (unity). A calculation of the potential peak annual TEDE within 1000 years to the average member of the critical group that would result from applying the radium standard, not including radon, on the site must be submitted for approval. The use of decommissioning plans with benchmark doses which exceed 100 mrem/yr, before application of ALARA, requires the approval of the department. This requirement for dose

criteria does not apply to sites that have decommissioning plans for soil and structures approved before June 11, 1999.

(h) The licensee shall also address the nonradiological hazards associated with the wastes in planning and implementing closure. The licensee shall ensure that disposal areas are closed in a manner that minimizes the need for further maintenance. To the extent necessary to prevent threats to human health and the environment, the licensee shall control, minimize, or eliminate post-closure escape of nonradiological hazardous constituents, leachate, contaminated rainwater, or waste decomposition products to the ground or surface waters or to the atmosphere.

¹ In the case of thorium by-product materials, the standard applies only to design. Monitoring for radon emissions from thorium by-product materials after installation of an appropriately designed cover is not required.

² This average applies to the entire surface of each disposal area over a period of at least one year, but a period short compared to 100 years. Radon will come from both by-product materials and from covering materials. Radon emissions from covering materials should be estimated as part of developing a closure plan for each site. The standard, however, applies only to emissions from by-product materials to the atmosphere.

Criterion 6A - (a) For impoundments containing uranium by-product materials, the final radon barrier must be completed as expeditiously as practicable considering technological feasibility after the pile or impoundment ceases operation in accordance with a written, department-approved reclamation plan. (The term as expeditiously as practicable considering technological feasibility as specifically defined in WAC 246-252-010 includes factors beyond the control of the licensee.) Deadlines for completion of the final radon barrier and, if applica-

ble, the following interim milestones must be established as a condition of the individual license: Windblown tailings retrieval and placement on the pile and interim stabilization (including dewatering or the removal of freestanding liquids and recontouring). The placement of erosion protection barriers or other features necessary for long-term control of the tailings must also be completed in a timely manner in accordance with a written, approved reclamation plan.

(b) The department may approve a licensee's request to extend the time for performance of milestones related to emplacement of the final radon barrier if, after providing an opportunity for public participation, the department finds that the licensee has adequately demonstrated in the manner required in subsection (6)(b) of this section (Criterion 6) that releases of Radon-222 do not exceed an average of 20 pCi/m²s. If the delay is approved on the basis that the radon releases do not exceed 20 pCi/m²s, a verification of radon levels, as required by subsection (6)(b) of this section (Criterion 6), must be made annually during the period of delay. In addition, once the department has established the date in the reclamation plan for the milestone for completion of the final radon barrier, the department may extend that date based on cost if, after providing an opportunity for public participation, the department finds that the licensee is

making good faith efforts to emplace the final radon barrier, the delay is consistent with the definitions of available technology, and the radon releases caused by the delay will not result in a significant incremental risk to the public health.

(c) The department may authorize by license amendment, upon licensee request, a portion of the impoundment to accept uranium by-product material or such materials that are similar in physical, chemical, and radiological characteristics to the uranium mill tailings and associated wastes already in the pile or impoundment from other sources, during the closure process. No such authorization will be made if it results in a delay or impediment to emplacement of the final radon barrier over the remainder of the impoundment in a manner that will achieve levels of Radon-222 releases not exceeding 20 pCi/m²s averaged over the entire impoundment. The verification required in subsection (6)(b) of this section (Criterion 6) may be completed with a portion of the impoundment being used for further disposal if the department makes a final finding that the impoundment will continue to achieve a level of Radon-222 releases not exceeding 20 pCi/m²s averaged over the entire impoundment. In this case, after the final radon barrier is complete except for the continuing disposal area:

(i) Only by-product material will be authorized for disposal;

(ii) The disposal will be limited to the specified existing disposal area; and

(iii) This authorization will only be made after providing opportunity for public participation.

Reclamation of the disposal area, as appropriate, must be completed in a timely manner after disposal operations cease in accordance with subsection (6)(a) of this section (Criterion 6); however, these actions are not required to be complete as part of meeting the deadline for final radon barrier construction.

(7) Criterion 7 - At least one full year prior to any major site construction, a preoperational monitoring program must be conducted to provide complete baseline data on a milling site and its environs. Throughout the construction and operating phases of the mill, an operational monitoring program must be conducted to complete the following:

(a) To measure or evaluate compliance with applicable standards and regulations;

(b) To evaluate performance of control systems and procedures;

(c) To evaluate environmental impacts of operation; and

(d) To detect potential long-term effects.

The licensee shall establish a detection monitoring program needed for the department to set the site-specific groundwater protection standards in Criterion 5 of this section. For all monitoring under this paragraph, the licensee or applicant will propose for department approval as license conditions, which constituents are to be monitored on a site-specific basis. A detection monitoring program has two purposes. The initial purpose of the program is to detect leakage of hazardous constituents from the disposal area so that the need to set groundwater protection standards is monitored. If leakage is detected, the second purpose of the program is to generate data and information needed for the department to establish the standards under Criterion 5. The data and information must provide a sufficient basis to identify those hazardous constituents which require concentration limit standards and to enable the department to set the limits for those constituents and the compliance period. They may also need to provide the basis for adjustments to the point of compliance. For licenses in effect September 30, 1983, the detection monitoring programs must have been in place by October 1, 1984. For licenses issued after September 30, 1983, the detection monitoring programs must be in place when specified by the department in orders or license conditions. Once groundwater protection standards have been established pursuant to

Criterion 5, the licensee shall establish and implement a compliance monitoring program. The purpose of the compliance monitoring program is to determine that the hazardous constituent concentrations in groundwater continue to comply with the standards set by the department. In conjunction with a corrective action program, the licensee shall establish and implement a corrective action monitoring program. The purpose of the corrective action monitoring program is to demonstrate the effectiveness of the corrective actions. Any monitoring program required by this paragraph may be based on existing monitoring programs to the extent the existing programs can meet the stated objective for the program.

(8) Criterion 8 - Milling operations shall be conducted so that all airborne effluent releases are reduced to as low as is reasonably achievable. The primary means of accomplishing this shall be by means of emission controls. Institutional controls, such as extending the site boundary and exclusion area, may be employed to ensure that off-site exposure limits are met, but only after all practicable measures have been taken to control emissions at the source. Notwithstanding the existence of individual dose standards, strict control of emissions is necessary to assure that population exposures are reduced to the maximum extent reasonably achievable and to avoid site contamina-

tion. The greatest potential sources of off-site radiation exposure (aside from radon exposure) are dusting from dry surfaces of the tailings disposal area not covered by tailings solution and emissions from yellowcake drying and packaging operations. During operations and prior to closure, radiation doses from radon emissions from surface impoundments shall be kept as low as is reasonably achievable. Checks shall be made and logged hourly of all parameters (e.g., differential pressure and scrubber water flow rate) which determine the efficiency of yellowcake stack emission control equipment operation. It shall be determined whether or not conditions are within a range prescribed to ensure that the equipment is operating consistently near peak efficiency; corrective action shall be taken when performance is outside of prescribed ranges. Effluent control devices shall be operative at all times during drying and packaging operations and whenever air is exhausting from the yellowcake stack.

Drying and packaging operations shall terminate when controls are inoperative. When checks indicate the equipment is not operating within the range prescribed for peak efficiency, actions shall be taken to restore parameters to the prescribed range. When this cannot be done without shutdown and repairs, drying and packaging operations shall cease as soon as practicable.

Operations may not be restarted after cessation due to off-normal performance until needed corrective actions have been identified and implemented. All such cessations, corrective actions, and restarts shall be reported to the department in writing, within ten days of the subsequent restart.

To control dusting from tailings, that portion not covered by standing liquids shall be wetted or chemically stabilized to prevent or minimize blowing and dusting to the maximum extent reasonably achievable. This requirement may be relaxed if tailings are effectively sheltered from wind, such as may be the case where they are disposed of below grade and the tailings surface is not exposed to wind. Consideration shall be given in planning tailings disposal programs to methods which would allow phased covering and reclamation of tailings impoundments since this will help in controlling particulate and radon emissions during operation. To control dustings from diffuse sources, such as tailings and ore pads where automatic controls do not apply, operators shall develop written operating procedures specifying the methods of control which will be utilized.

Milling operations producing or involving thorium by-product material shall be conducted in such a manner as to provide reasonable assurance that the annual dose equivalent does not exceed twenty-five

millirems to the whole body, seventy-five millirems to the thyroid, and twenty-five millirems to any other organ of any member of the public as a result of exposures to the planned discharge of radioactive materials, Radon-220 and its daughters excepted, to the general environment.

Uranium and thorium by-product materials shall be managed so as to conform to the applicable provisions of Title 40 of the Code of Federal Regulations, Part 440, Ore Mining and Dressing Point Source Category: Effluent Limitations Guidelines and New Source Performance Standards, Subpart C, Uranium, Radium, and Vanadium Ores Subcategory, as codified on January 1, 1983.

The licensee shall establish a detection monitoring program needed to establish the groundwater protection standards in subsection (5)(f) of this section. A detection monitoring program has two purposes. The initial purpose of the program is to detect leakage of hazardous constituents from the disposal area so that the need to set groundwater protection standards is monitored. If leakage is detected, the second purpose of the program is to generate data and information needed for the department to establish the standards under subsection (5)(f) of this section. The data and information must provide a sufficient basis to identify those hazardous constituents which require

concentration limit standards and to enable the department to set the limits for those constituents and the compliance period. They may also need to provide the basis for adjustments to the point of compliance. For licenses in effect September 30, 1983, the detection monitoring programs must have been in place by October 1, 1984. For licenses issued after September 30, 1983, the detection monitoring programs must be in place when specified by the department in orders or license conditions. Once groundwater protection standards have been established pursuant to subsection (5)(f) of this section, the licensee shall establish and implement a compliance monitoring program. The purpose of the compliance monitoring program is to determine that the hazardous constituent concentrations in groundwater continue to comply with the standards set by the department. In conjunction with a corrective action program, the licensee shall establish and implement a corrective action monitoring program. The purpose of the corrective action monitoring program is to demonstrate the effectiveness of the corrective actions. Any monitoring program required by this paragraph may be based on existing monitoring programs to the extent the existing programs can meet the stated objective for the program.

Daily inspections of tailings or waste retention systems must be conducted by a qualified engineer or scientist and documented. The de-

partment must be immediately notified of any failure in a tailings or waste retention system that results in a release of tailings or waste into unrestricted areas, or of any unusual conditions (conditions not contemplated in the design of the retention system) which if not corrected could indicate the potential or lead to failure of the system and result in a release of tailings or waste into unrestricted areas.

(9) Criterion 9 - (a) Pursuant to chapter 70.121 RCW, and except as otherwise provided, financial surety arrangements must be established by each mill operator before the commencement of operations to assure that sufficient funds will be available to carry out the decontamination and decommissioning of the mill and site and for the reclamation of any tailings or waste disposal areas. The amount of funds to be ensured by such surety arrangements must be based on department-approved cost estimates in a department-approved plan, or a proposed revision to the plan submitted to the department for approval, if the proposed revision contains a higher cost estimate for:

(i) Decontamination and decommissioning of mill buildings and the milling site to levels which allow unrestricted use of these areas upon decommissioning; and

(ii) The reclamation of tailings or waste areas in accordance with technical criteria delineated in this section.

(b) Each cost estimate must contain:

(i) A detailed cost estimate for decontamination, decommissioning, and reclamation, in an amount reflecting:

(A) The cost of an independent contractor to perform the decontamination, decommissioning, and reclamation activities; and

(B) An adequate contingency factor.

(ii) An estimate of the amount of radioactive contamination in on-site subsurface material;

(iii) Identification of and justification for using the key assumptions contained in the decommissioning cost estimate; and

(iv) A description of the method of assuring funds for decontamination, decommissioning, and reclamation.

(c) The licensee shall submit this plan in conjunction with an environmental report that addresses the expected environmental impacts of the milling operation, decommissioning and tailings reclamation, and evaluates alternatives for mitigating these impacts. The plan must include a signed original of the financial instrument obtained to satisfy the surety arrangement requirements of this criterion (unless a previously submitted and approved financial instrument continues to cover the cost estimate for decommissioning). The surety arrangement must also cover the cost estimate and the payment of the charge for

long-term surveillance and control required by subsection (10) of this section.

(d) To avoid unnecessary duplication and expense, the department may accept financial sureties that have been consolidated with financial or surety arrangements established to meet requirements of other federal or state agencies or local governing bodies for decommissioning, decontamination, reclamation, and long-term site surveillance and control, provided such arrangements are considered adequate to satisfy these requirements and that the portion of the surety which covers the decommissioning and reclamation of the mill, mill tailings site and associated areas, and the long-term funding charge is clearly identified and committed for use in accomplishing these activities.

(e) The licensee's surety mechanism will be reviewed annually by the department to assure, that sufficient funds would be available for completion of the reclamation plan if the work had to be performed by an independent contractor.

(f) The amount of surety liability should be adjusted to recognize any increases or decreases resulting from:

- (i) Inflation;
- (ii) Changes in engineering plans;
- (iii) Activities performed;

(iv) Spills, leakage or migration of radioactive material producing additional contamination in on-site subsurface material that must be remediated to meet applicable remediation criteria;

(v) Waste inventory increasing above the amount previously estimated;

(vi) Waste disposal costs increasing above the amount previously estimated;

(vii) Facility modifications;

(viii) Changes in authorized possession limits;

(ix) Actual remediation costs that exceed the previous cost estimate;

(x) On-site disposal; and

(xi) Any other conditions affecting costs.

(g) Regardless of whether reclamation is phased through the life of the operation or takes place at the end of operations, an appropriate portion of surety liability must be retained until final compliance with the reclamation plan is determined.

(h) The appropriate portion of surety liability retained until final compliance with the reclamation plan is determined will be at least sufficient at all times to cover the costs of decommissioning and reclamation of the areas that are expected to be disturbed before

the next license renewal. The term of the surety mechanism must be open ended, unless it can be demonstrated that another arrangement would provide an equivalent level of assurance. This assurance would be provided with a surety instrument which is written for a specified time (for example five years) and which must be automatically renewed unless the surety notifies the department and the licensee with reasonable time (for example ninety days) before the renewal date of their intention not to renew. In such a situation the surety requirement still exists and the licensee would be required to submit an acceptable replacement surety within a brief time to allow at least sixty days for the department to collect.

(i) Proof of forfeiture must not be necessary to collect the surety. In the event that the licensee cannot provide an acceptable replacement surety within the required time, the surety shall be automatically collected before its expiration. The surety instrument must provide for collection of the full face amount immediately on demand without reduction for any reason, except for trustee fees and expenses provided for in a trust agreement, and that the surety will not refuse to make full payment. The conditions described previously would have to be clearly stated on any surety instrument which is not open-ended,

and must be agreed to by all parties. Financial surety arrangements generally acceptable to the department are:

(i) Trust funds;

(ii) Surety bonds;

(iii) Irrevocable letters of credit; and

(iv) Combinations of the financial surety arrangements or other types of arrangements as may be approved by the department. If a trust is not used, then a standby trust must be set up to receive funds in the event the department exercises its right to collect the surety. The surety arrangement and the surety or trustee, as applicable, must be acceptable to the department. Self-insurance, or any arrangement which essentially constitutes self-insurance (for example, a contract with a state or federal agency), will not satisfy the surety requirement because this provides no additional assurance other than that which already exists through license requirements.

(10) Criterion 10 - (a) A minimum charge of two hundred fifty thousand dollars (1978 United States dollars) accrued as specified in WAC 246-235-086(4) to cover the costs of long-term surveillance shall be paid by each mill operator to the agency prior to the termination of a uranium or thorium mill license. If site surveillance or control requirements at a particular site are determined, on the basis of a

site-specific evaluation, to be significantly greater than those specified in (a) of this subsection (e.g., if fencing is determined to be necessary), variance in funding requirements may be specified by the department. The total charge to cover the costs of long-term surveillance shall be such that, with an assumed one percent annual real interest rate, the collected funds will yield interest in an amount sufficient to cover the annual costs of site surveillance. The charge will be adjusted annually prior to actual payments to recognize inflation. The inflation rate to be used is that indicated by the change in the consumer price index published by the United States Department of Labor, Bureau of Labor Statistics. Contributions by a licensee to the long-term care trust fund pursuant to chapter 70.121 RCW shall be transferred to cover the costs assessed under this criterion.

(11) Criterion 11 - These criteria relating to ownership of tailings and their disposal sites become effective on November 8, 1981, and apply to all licenses terminated, issued, or renewed after that date.

Any uranium or thorium milling license or tailings license shall contain such terms and conditions as NRC determines necessary to assure that prior to termination of the license, the licensee will com-

ply with ownership requirements of this criterion for sites used for tailings disposal.

Title to the by-product material licensed pursuant to WAC 246-252-030 and land, including any interests therein (other than land owned by the United States or by the state of Washington) which is used for the disposal of any such by-product material, or is essential to ensure the long-term stability of such disposal site, shall be transferred to the United States or the state of Washington. In view of the fact that physical isolation must be the primary means of long-term control, and government land ownership is a desirable supplementary measure, ownership of certain severable subsurface interests (for example, mineral rights) may be determined to be unnecessary to protect the public health and safety and the environment. In any case, the applicant/operator must demonstrate a serious effort to obtain such subsurface rights, and must, in the event that certain rights cannot be obtained, provide notification in local public land records of the fact that the land is being used for the disposal of radioactive material and is subject to either a NRC general or specific license prohibiting the disruption and disturbance of the tailings. In some rare cases, such as may occur with deep burial where no ongoing site surveillance will be required, surface land ownership transfer

requirements may be waived. For licenses issued before November 8, 1981, NRC may take into account the status of the ownership of such land, and interests therein, and the ability of a licensee to transfer title and custody thereof to the United States or the state. If NRC, subsequent to title transfer, determines that use of the surface or subsurface estates, or both, of the land transferred to the United States or to a state will not endanger the public health, safety, welfare or environment, NRC may permit the use of the surface or subsurface estates, or both, of such land in a manner consistent with the provisions provided in these criteria. If NRC permits such use of such land, it will provide the person who transferred such land with the right of first refusal with respect to such use of such land.

Material and land transferred to the United States or a state in accordance with this criterion must be transferred without cost to the United States or a state other than administrative and legal costs incurred in carrying out such transfer.

The provisions of this part, respecting transfer of title and custody to land and tailings and wastes, do not apply in the case of lands held in trust by the United States for any Indian Tribe, or lands owned by such Indian Tribe subject to a restriction against alienation imposed by the United States. In the case of such lands which

are used for the disposal of by-product material, as defined in this section, the licensee shall enter into arrangements with NRC as may be appropriate to assure the long-term surveillance of such lands by the United States.

(12) Criterion 12 - The final disposition of tailings or wastes at milling sites should be such that ongoing active maintenance is not necessary to preserve isolation. As a minimum, annual site inspections must be conducted by the government agency retaining ultimate custody of the site where tailings or wastes are stored, to confirm the integrity of the stabilized tailings or waste systems, and to determine the need, if any, for maintenance or monitoring. Results of the inspection must be reported to NRC within sixty days following each inspection. NRC may require more frequent site inspections if, on the basis of a site-specific evaluation, such a need appears necessary, due to the features of a particular tailings or waste disposal system.

(13) Criterion 13 - Secondary groundwater protection standards required by Criterion 5 of this section are concentration limits for individual hazardous constituents. The list of constituents found in Appendix A of this chapter, chapter 246-252 WAC, identifies the constituents for which standards must be set and complied with if the specific constituent is reasonably expected to be in or derived from

the by-product material and has been detected in groundwater. For purposes of this criterion, the property of gross alpha activity will be treated as if it is a hazardous constituent. Thus, when setting standards under subsection (5)(j) of this section, the department will also set a limit for gross alpha activity.

[Statutory Authority: RCW 70.98.050 and 70.98.110. WSR 17-01-034, § 246-252-030, filed 12/12/16, effective 1/12/17; WSR 16-13-054, § 246-252-030, filed 6/10/16, effective 7/11/16. Statutory Authority: RCW 70.98.050. WSR 15-06-015, § 246-252-030, filed 2/23/15, effective 3/26/15. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 02-17-005, § 246-252-030, filed 8/8/02, effective 9/8/02. Statutory Authority: RCW 70.98.050. WSR 00-08-013, § 246-252-030, filed 3/24/00, effective 4/24/00; WSR 97-13-055, § 246-252-030, filed 6/16/97, effective 7/17/97; WSR 94-01-073, § 246-252-030, filed 12/9/93, effective 1/9/94. Statutory Authority: RCW 70.98.050 and 70.98.080. WSR 91-16-109 (Order 187), § 246-252-030, filed 8/7/91, effective 9/7/91. Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-252-030, filed 12/27/90, effective 1/31/91. Statutory Authority: RCW 70.98.080. WSR 87-01-031 (Order 2450), § 402-52-100, filed 12/11/86. Statutory Authority: Chapter 70.121 RCW. WSR 81-16-031 (Order 1683), § 402-52-100, filed 7/28/81.]

WAC 246-252-040 Continuing dose assessment. Each uranium or thorium milling operation shall submit in writing to the department by May 1 and November 1 of each year, reports specifying the quantities of each of the principle radionuclides released to unrestricted areas in liquid and in gaseous effluent during the previous six months of operations. This data shall be reported in a manner that will permit the department to confirm the potential annual radiation doses to the public. All data from the radiological and nonradiological environmental monitoring program will also be submitted for the same time period and frequency as specified above. The data shall be reported in a manner which will allow the department to confirm the potential annual radiation doses to the public. In addition, the report due each May 1 shall include a dose assessment to assure compliance with 40 C.F.R. 190 Environmental Radiation Protection Standards for Nuclear Power Operation and an annual land use survey to include but not be limited to water supply information, location and number of occupants, time spent at each location by occupants, amount and type of locally grown stored feed and amount of pasture consumed by local livestock.

[Statutory Authority: RCW 43.70.040. WSR 91-02-049 (Order 121), recodified as § 246-252-040, filed 12/27/90, effective 1/31/91. Statutory

Authority: Chapter 70.121 RCW. WSR 81-16-031 (Order 1683), § 402-52-200, filed 7/28/81.]

WAC 246-252-050 Appendix A.

Hazardous Constituents

Acetonitrile (Ethanenitrile)
Acetophenone (Ethanone, 1-phenyl)
3-(alpha-Acetylbenzyl)-4-hydroxycoumarin and salts (Warfarin)
2-Acetylaminofluorene (Acetamide, N-(9H-fluoren-2-yl)-)
Acetyl chloride (Ethanoyl chloride)
1-Acetyl-2-thiourea (Acetamide, N-(aminothioxomethyl)-)
Acrolein (2-Propenal)
Acrylamide (2-Propenamide)
Acrylonitrile (2-Propenenitrile)
Aflatoxins
Aldrin (1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a,8b-hexahydro-endo, exo-1,4:5,8-Dimethanonaphthalene)
Allyl alcohol (2-Propen-1-ol)
Aluminum phosphide
4-Aminobiphenyl ([1,1'-Biphenyl]-4-amine)
6-Amino-1,1a,2,8,8a,8b-hexahydro-8-(hydroxymethyl)-8a-methoxy-5-methyl-carbamate azirino[2,3':3,4] pyrrolo [1,2-a] indole-4,7-dione, (ester) (Mitomycin C) (Azirino[2'3':3,4] pyrrolo (1,2-a) indole-4,7-dione, 6-amino-8-[(amino-carbonyl)oxy)methyl]-1,1a,2,8,8a,8b-hexahydro-8a methoxy-5-methy-)
5-(Aminomethyl)-3-isoxazolol (3(2H)-Isoxazolone, 5-(aminomethyl)-) 4-Aminopyridine (4-Pyridinamine)
Amitrole (1H-1,2,4-Triazol-3-amine)
Aniline (Benzenamine)
Antimony and compounds, N.O.S.*
Aramite (Sulfurous acid, 2-chloroethyl-, 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester)
Arsenic and compounds, N.O.S.*
Arsenic acid (Orthoarsenic acid)
Arsenic pentoxide (Arsenic (V) oxide)
Arsenic trioxide (Arsenic (III) oxide)
Auramine (Benzenamine, 4,4'-carbonimidoylbis [N,N-Dimethyl-, monohydrochloride)
Azaserine (L-Serine, diazoacetate (ester))
Barium and compounds, N.O.S.*
Barium cyanide
Benz[c]acridine (3,4-Benzacridine)
Benz[a]anthracene (1,2-Benzanthracene)
Benzene (Cyclohexatriene)
Benzenearsonic acid (Arsonic acid, phenyl-)
Benzene, dichloromethyl- (Benzal chloride)
Benzenethiol (Thiophenol)
Benzidine ([1,1'-Biphenyl]-4,4'diamine)
Benzo[b]fluoranthene (2,3-Benzofluoranthene)
Benzo[j]fluoranthene (7,8-Benzofluoranthene)
Benzo[a]pyrene (3,4-Benzopyrene)
p-Benzoquinone (1,4-Cyclohexadienedione)
Benzotrichloride (Benzene, trichloromethyl)
Benzyl chloride (Benzene, (chloromethyl)-)

Beryllium and compounds, N.O.S.*
 Bis(2-chloroethoxy)methane (Ethane, 1,1'-[methylenebis(oxy)]bis[2-chloro-])
 Bis(2-chloroethyl) ether (Ethane, 1,1'-oxybis[2-chloro-])
 N,N-Bis(2-chloroethyl)-2-naphthylamine (Chlornaphazine)
 Bis(2-chloroisopropyl) ether (Propane, 2,2'-oxybis[2-chloro-])
 Bis(chloromethyl) ether (Methane, oxybis[chloro-])
 Bis(2-ethylhexyl) phthalate (1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester)
 Bromoacetone (2-Propanone, 1-bromo-)
 Bromomethane (Methyl bromide)
 4-Bromophenyl phenyl ether (Benzene, 1-bromo-4-phenoxy-)
 Brucine (Strychnidin-10-one, 2,3-dimethoxy-)
 2-Butanone peroxide (Methyl ethyl ketone, peroxide)
 Butyl benzyl phthalate (1,2-Benzenedicarboxylic acid, butyl phenylmethyl ester)
 2-sec-Butyl-4,6-dinitrophenol (DNBP) (Phenol, 2,4-dinitro-6-(1-methylpropyl)-)
 Cadmium and compounds, N.O.S.*
 Calcium chromate (Chromic acid, calcium salt)
 Calcium cyanide
 Carbon disulfide (Carbon bisulfide)
 Carbon oxyfluoride (Carbonyl fluoride)
 Chloral (Acetaldehyde, trichloro-)
 Chlorambucil (Butanoic acid, 4-[bis(2-chloroethyl)amino]benzene-)
 Chlordane (alpha and gamma isomers) (4,7-Methanoindan, 1,2,4,5,6,7,8,8-octachloro-3,4,7,7a-tetrahydro-) (alpha and gamma isomers)
 Chlorinated benzenes, N.O.S.*
 Chlorinated ethane, N.O.S.*
 Chlorinated fluorocarbons, N.O.S.*
 Chlorinated naphthalene, N.O.S.*
 Chlorinated phenol, N.O.S.*
 Chloroacetaldehyde (Acetaldehyde, chloro-)
 Chloroalkyl ethers, N.O.S.*
 p-Chloroaniline (Benzenamine, 4-chloro-)
 Chlorobenzene (Benzene, chloro-)
 Chlorobenzilate (Benzenoacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-, ethyl ester)
 p-Chloro-m-cresol (Phenol, 4-chloro-3-methyl)
 1-Chloro-2,3-epoxypropane (Oxirane, 2-(chloromethyl)-)
 2-Chloroethyl vinyl ether (Ethene, (2-chloroethoxy)-)
 Chloroform (Methane, trichloro-)
 Chloromethane (Methyl chloride)
 Chloromethyl methyl ether (Methane, chloromethoxy-)
 2-Chloronaphthalene (Naphthalene, betachloro-)
 2-Chlorophenol (Phenol, o-chloro-)
 1-(o-Chlorophenyl)thiourea (Thiourea, (2-chlorophenyl)-)
 3-Chloropropionitrile (Propanenitrile, 3-chloro-)
 Chromium and compounds, N.O.S.*
 Chrysene (1,2-Benzphenanthrene)
 Citrus red No. 2 (2-Naphthol, 1-[(2,5-dimethoxyphenyl)azo]-)
 Coal tars
 Copper cyanide
 Creosote (Creosote, wood)
 Cresols (Cresylic acid) (Phenol, methyl-)
 Crotonaldehyde (2-Butenal)
 Cyanides (soluble salts and complexes), N.O.S.*
 Cyanogen (Ethanedinitrile)
 Cyanogen bromide (Bromide cyanide)
 Cyanogen chloride (Chlorine cyanide)

Cycasin(beta-D-Glucopyranoside, (methyl-ONN-azoxy)methyl-)
 2-Cyclohexyl-4,6-dinitrophenol (Phenol, 2-cyclohexyl-4,6-dinitro-)
 Cyclophosphamide (2H-1,3,2, -Oxazaphosphorine, [bis(2-chloroethyl) amino]-tetrahydro-,2-oxide)
 Daunomycin (5,12-Naphthacenedione, (8S-cis)-8-acetyl-10-[(3-amino-2,3,6-trideoxy)-alpha-L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-)
 DDD (Dichlorodiphenyldichloroethane) (Ethane, 1,1-dichloro-2,2-bis(p-chlorophenyl)-)
 DDE (Ethylene, 1,1-dichloro-2,2-bis(4-chlorophenyl)-)
 DDT (Dichlorodiphenyltrichloroethane) (Ethane, 1,1,1-trichloro-2,2-bis(p-chlorophenyl)-)
 Diallylate (S-(2,3-dichloroallyl) diisopropylthiocarbamate)
 Dibenz[a,h]acridine (1,2,5,6-Dibenzacridine)
 Dibenz[a,j]acridine (1,2,7,8-Dibenzacridine)
 Dibenz[a,h]anthracene (1,2,5,6-Dibenzanthracene)
 7H-Dibenzo[c,g]carbazole (3,4,5,6-Dibenzcarbazole)
 Dibenzo[a,e]pyrene (1,2,4,5-Dibenzpyrene)
 Dibenzo[a,h]pyrene (1,2,5,6-Dibenzpyrene)
 Dibenzo[a,i]pyrene (1,2,7,8-Dibenzpyrene)
 1,2-Dibromo-3-chloropropane (Propane, 1,2-dibromo-3-chloro-)
 1,2-Dibromoethane (Ethylene dibromide)
 Dibromomethane (Methylene bromide)
 Di-n-butyl phthalate (1,2-Benzenedicarboxylic acid, dibutyl ester)
 o-Dichlorobenzene (Benzene, 1,2-dichloro-)
 m-Dichlorobenzene (Benzene, 1,3-dichloro-)
 p-Dichlorobenzene (Benzene, 1,4-dichloro-)
 Dichlorobenzene, N.O.S.* (Benzene, dichloro-, N.O.S.*)
 3,3'-Dichlorobenzidine ([1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-)
 1,4-Dichloro-2-butene (2-Butene, 1,4-dichloro-)
 Dichlorodifluoromethane (Methane, dichlorodifluoro-)
 1,1-Dichloroethane (Ethylidene dichloride)
 1,2-Dichloroethane (Ethylene dichloride)
 trans-1,2-Dichloroethene (1,2-Dichloroethylene)
 Dichloroethylene, N.O.S.* (Ethene, dichloro-, N.O.S.*)
 1,1-Dichloroethylene (Ethene, 1,1-dichloro-)
 Dichloromethane (Methylene chloride)
 2,4-Dichlorophenol (Phenol, 2,4-dichloro-)
 2,6-Dichlorophenol (Phenol, 2,6-dichloro-)
 2,4-Dichlorophenoxyacetic acid (2,4-D), salts and esters (Acetic acid, 2,4-dichlorophenoxy-, salts and esters)
 Dichlorophenylarsine (Phenyl dichloroarsine)
 Dichloropropane, N.O.S.* (Propane, dichloro-, N.O.S.*)
 1,2-Dichloropropane (Propylene dichloride)
 Dichloropropanol, N.O.S.* (Propanol, dichloro-, N.O.S.*)
 Dichloropropene, N.O.S.* (Propene, dichloro-, N.O.S.*)
 1,3-Dichloropropene (1-Propene, 1,3-dichloro-)
 Dieldin (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octa-hydro-endo, exo-1,4:5,8-Dimethanonaphthalene)
 1,2:3,4-diepoxybutane (2,2'-Bioxirane)
 Diethylarsine (Arsine, diethyl-)
 N,N-Diethylhydrazine (Hydrazine, 1,2-diethyl)
 O,O-Diethyl S-methyl ester of phosphorodithioic acid (Phosphorodithioic acid, O,O-diethyl S-methyl ester)
 O,O-Diethylphosphoric acid, O-p-nitrophenyl ester (Phosphoric acid, diethyl p-nitrophenyl ester)
 Diethyl phthalate (1,2-Benzenedicarboxylic acid, diethyl ester)
 O,O-Diethyl O-2-pyrazinyl phosphorothioate (Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester)
 Diethylstilbesterol (4,4'-Stilbenediol, alpha, alpha-diethyl, bis(dihydrogen phosphate, (E)-)
 Dihydrosafrole (Benzene, 1,2-methylenedioxy-4-propyl-)

3,4-Dihydroxy-alpha-(methylamino)methyl benzyl alcohol (1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-)

Dilsopropylfluorophosphate (DFP) (Phosphorofluoric acid, bis(1-methylethyl) ester)

Dimethoate (Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester)

3,3'-Dimethoxybenzidine ([1,1'-Biphenyl]-4,4'-diamine, 3,3'-di-methoxy-)

p-Dimethylaminoazobenzene (Benzenamine, N,N-dimethyl-4-(phenylazo)-)

7,12-Dimethylbenz[a]anthracene (1,2-Benzanthracene, 7,12-dimethyl-)

3,3'-Dimethylbenzidine ([1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-)

Dimethylcarbamoyl chloride (Carbamoyl chloride, dimethyl-)

1,1-Dimethylhydrazine (Hydrazine, 1,1-dimethyl-)

1,2-Dimethylhydrazine (Hydrazine, 1,2-dimethyl-)

3,3-Dimethyl-1-(methylthio)-2-butanone, O-[(methylamino) carbonyl] oxime (Thiofanox)

alpha, alpha-Dimethylphenethylamine (Ethanamine, 1,1-dimethyl-2-phenyl-)

2,4-Dimethylphenol (Phenol, 2,4-dimethyl-)

Dimethyl phthalate (1,2-Benzenedicarboxylic acid, dimethyl ester)

Dimethyl sulfate (Sulfuric acid, dimethyl ester)

Dinitrobenzene, N.O.S.* (Benzene, dinitro-, N.O.S.*)

4,6-Dinitro-o-cresol and salts (Phenol, 2,4-dinitro-6-methyl-, and salts)

2,4-Dinitrophenol (Phenol, 2,4-dinitro-)

2,4-Dinitrotoluene (Benzene, 1-methyl-2,4-dinitro-)

2,6-Dinitrotoluene (Benzene, 1-methyl-2,6-dinitro-)

Di-n-octyl phthalate (1,2-Benzenedicarboxylic acid, dioctyl ester)

1,4-Dioxane (1,4-Diethylene oxide)

Diphenylamine (Benzenamine, N-phenyl-)

1,2-Diphenylhydrazine (Hydrazine, 1,2-diphenyl-)

Di-n-propylnitrosamine (N-Nitroso-di-n-propylamine)

Disulfoton (O,O-diethyl S-[2-(ethylthio)ethyl] phosphorodithioate)

2,4-Dithiobiuret (Thioimidodicarbonic diamide)

Endosulfan (5-Norbornene, 2,3-dimethanol, 1,4,5,6,7,7-hexachloro-, cyclic sulfite)

Endrin and metabolites (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4:5,8-dimethanonaphthalene, and metabolites)

Ethyl carbamate (Urethan) (Carbamic acid, ethyl ester)

Ethyl cyanide (propanenitrile)

Ethylenebisdithiocarbamic acid, salts and esters
(1,2-Ethanediybiscarbamodithioic acid, salts and esters)

Ethyleneimine (Aziridine)

Ethylene oxide (Oxirane)

Ethylenethiourea (2-Imidazolidinethione)

Ethyl methacrylate (2-Propenoic acid, 2-methyl-, ethyl ester)

Ethyl methanesulfonate (Methanesulfonic acid, ethyl ester)

Fluoranthene (Benzo[j,k]fluorene)

Fluorine

2-Fluoroacetamide (Acetamide, 2-fluoro-)

Fluoroacetic acid, sodium salt (Acetic acid, fluoro-, sodium salt)

Formaldehyde (Methylene oxide)

Formic acid (Methanoic acid)

Glycidylaldehyde (1-Propanol-2,3-epoxy)

Halomethane, N.O.S.*

Heptachlor (4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-)

Heptachlor epoxide (alpha, beta, and gamma isomers) (4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-2,3-epoxy-3a,4,7,7-tetrahydro-, alpha, beta, and gamma isomers)

Hexachlorobenzene (Benzene, hexachloro-)

Hexachlorobutadiene (1,3-Butadiene, 1,1,2,3,4,4-hexachloro-)

Hexachlorocyclohexane (all isomers) (Lindane and isomers)
Hexachlorocyclopentadiene (1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-)
Hexachloroethane (Ethane, 1,1,1,2,2,2-hexachloro-)
1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-endo, endo-
dimethanonaphthalene (Hexachlorohexa-hydro-endo, endo-
dimethanonaphthalene)
Hexachlorophene (2,2'-Methylenebis(3,4,6-trichlorphenol)
Hexachloropropene (1-Propene, 1,1,2,3,3,3-hexachloro-)
Hexaethyl tetraphosphate (Tetraphosphoric acid, hexaethyl ester)
Hydrazine (Diamine)
Hydrocyanic acid (Hydrogen cyanide)
Hydrofluoric acid (Hydrogen fluoride)
Hydrogen sulfide (Sulfur hydride)
Hydroxydimethylarsine oxide (Cacodylic acid)
Indeno (1,2,3-cd)pyrene (1,10-(1,2-phenylene)pyrene)
Iodomethane (Methyl iodide)
Iron dextran (Ferric dextran)
Isocyanic acid, methyl ester (Methyl isocyanate)
Isobutyl alcohol (1-Propanol, 2-methyl-)
Isosafrole (Benzene, 1,2-methylenedioxy-4-allyl-)
Kepone (Decachlorooctahydro-1,3,4-Methano-2H-cyclobuta[cd]pentalen-
2-one)
Lasiocarpine (2-Butenoic acid, 2-methyl-,7-[(2,3-dihydroxy-2-(1-
methoxyethyl)-3-methyl-1-oxobutoxy)methyl]-2,3,5,7a-tetrahydro-
1H-pyrrolizin-1-yl ester)
Lead and compounds, N.O.S.*
Lead acetate (Acetic acid, lead salt)
Lead phosphate (Phosphoric acid, lead salt)
Lead subacetate (Lead, bis(acetato-0)tetrahydroxytri-)
Maleic anhydride (2,5-Furandione)
Maleic hydrazide (1,2-Dihydro-3,6-pyridazinedione)
Malononitrile (Propanedinitrile)
Melfhalan (Alanine, 3-[p-bis(2-chloroethyl)amino]phenyl-,L-)
Mercury fulminate (Fulminic acid, mercury salt)
Mercury and compounds, N.O.S.*
Methacrylonitrile (2-Propenenitrile, 2-methyl-)
Methanethiol (Thiomethanol)
Methapyrilene (Pyridine, 2-[(2-dimethylamino)ethyl]-2-thenylamino-)
Metholmyl (Acetimidic acid, N-[(methylcarbamoyl)oxy]thio-, methyl
ester)
Methoxychlor (Ethane, 1,1,1-trichloro-2,2'-bis(p-methoxyphenyl)-)
2-Methylaziridine (1,2-Propylenimine)
3-Methylcholanthrene (Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-)
Methyl chlorocarbonate (Carbonochloridic acid, methyl ester)
4,4'-Methylenebis(2-chloroaniline) (Benzenamine, 4,4'-methylenebis-(2-
chloro-)
Methyl ethyl ketone (MEK) (2-Butanone)
Methyl hydrazine (Hydrazine, methyl-)
2-Methylactonitrile (Propanenitrile, 2-hydroxy-2-methyl-)
Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)
Methyl methanesulfonate (Methanesulfonic acid, methyl ester)
2-Methyl-2-(methylthio)propionaldehyde-o-(methylcarbonyl) oxime
(Propanal, 2-methyl-2-(methylthio)-, 0-
[(methylamino)carbonyl]oxime)
N-Methyl-N'-nitro-N-nitrosoguanidine (Guanidine, N-nitroso-N-methyl-N'-
nitro-)
Methyl parathion (0,0-dimethyl 0-(4-nitrophenyl) phosphorothioate)
Methylthiouracil (4-1H-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-)
Molybdenum and compounds, N.O.S.*
Mustard gas (Sulfide, bis(2-chloroethyl)-)
Naphthalene
1,4-Naphthoquinone (1, 4-Naphthalenedione)

1-Naphthylamine (alpha-Naphthylamine)
 2-Naphthylamine (beta-Naphthylamine)
 1-Naphthyl-2-thiourea (Thiourea, 1-naphthalenyl-)
 Nickel and compounds, N.O.S.*
 Nickel carbonyl (Nickel tetracarbonyl)
 Nickel cyanide (Nickel (II) cyanide)
 Nicotine and salts (Pyridine, (S)-3-(1-methyl-2-pyrrolidinyl)-, and salts)
 Nitric oxide (Nitrogen (II) oxide)
 p-Nitroaniline (Benzenamine, 4-nitro-)
 Nitrobenzene (Benzene, nitro-)
 Nitrogen dioxide (Nitrogen (IV) oxide)
 Nitrogen mustard and hydrochloride salt (Ethanamine, 2-chloro-, N-(2-chloroethyl)-N-methyl-, and hydrochloride salt)
 Nitrogen mustard N-Oxide and hydrochloride salt (Ethanamine, 2-chloro-N-(2-chloroethyl)-N-methyl-, and hydrochloride salt)
 Nitroglycerine (1,2,3-Propanetriol, trinitrate)
 4-Nitrophenol (Phenol, 4-nitro-)
 4-Nitroquinoline-1-oxide (Quinoline, 4-nitro-1-oxide-)
 Nitrosamine, N.O.S.*
 N-Nitrosodi-n-butylamine (1-Butanamine, N-butyl-N-nitroso-)
 N-Nitrosodiethanolamine (Ethanol, 2,2'-(nitrosoimino)bis-)
 N-Nitrosodiethylamine (Ethanamine, N-ethyl-N-nitroso-)
 N-Nitrosodimethylamine (Dimethylnitrosamine)
 N-Nitroso-N-ethylurea (Carbamide, N-ethyl-N-nitroso-)
 N-Nitrosomethylethylamine (Ethanamine, N-methyl-N-nitroso-)
 N-Nitroso-N-methylurea (Carbamide, N-methyl-N-nitroso-)
 N-Nitroso-N-methylurethane (Carbamic acid, methylnitroso-, ethyl ester)
 N-Nitrosomethylvinylamine (Ethenamine, N-methyl-N-nitroso-)
 N-Nitrosomorpholine (Morpholine, N-nitroso-)
 N-Nitrososarcosine (Sarcosine, N-nitroso-)
 N-Nitrosopiperidine (Pyridine, hexahydro-, N-nitroso-)
 Nitrosopyrrolidine (Pyrrole, tetrahydro-, N-nitroso-)
 N-Nitrososarcosine (Sarcosine, N-nitroso-)
 5-Nitro-o-toluidine (Benzenamine, 2-methyl-5-nitro-)
 Octamethylpyrophosphoramidate (Diphosphoramidate, octamethyl-)
 Osmium tetroxide (Osmium (VIII) oxide)
 7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid (Endothal)
 Paraldehyde (1,3,5-Trioxane, 2,4,6-trimethyl-)
 Parathion (Phosphorothioic acid, 0,0-diethyl 0-(p-nitrophenyl)ester)
 Pentachlorobenzene (Benzene, pentachloro-)
 Pentachloroethane (Ethane, pentachloro-)
 Pentachloronitrobenzene (PCNB) (Benzene, pentachloronitro-)
 Pentachlorophenol (Phenol, pentachloro-)
 Phenacetin (Acetamide, N-(4-ethoxyphenyl)-)
 Phenol (Benzene, hydroxy-)
 Phenylenediamine (Benzenediamine)
 Phenylmercury acetate (Mercury, acetatophenyl-)
 N-Phenylthiourea (Thiourea, phenyl-)
 Phosgene (Carbonyl chloride)
 Phosphine (Hydrogen phosphide)
 Phosphorodithioic acid, 0,0-diethyl S-[(ethylthio)methyl] ester (Phorate)
 Phosphorothioic acid, 0,0-dimethyl 0-[p-((dimethylamino)sulfonyl)phenyl] ester (Famphur)
 Phthalic acid esters, N.O.S.* (Benzene, 1, 2-dicarboxylic acid, esters, N.O.S.*)
 Phthalic anhydride (1,2-Benzenedicarboxylic acid anhydride)
 2-Picoline (Pyridine, 2-methyl-)
 Polychlorinated biphenyl, N.O.S.*
 Potassium cyanide
 Potassium silver cyanide (Argentate(1-), dicyano-, potassium)

Pronamide (3,5-Dichloro-N-(1,1-dimethyl-2-propynyl)benzamide)
 1,3-Propane sultone (1,2-Oxathiolane, 2,2-dioxide)
 n-Propylamine (1-Propanamine)
 Propylthiouracil (Undecamethylenediamine, N,N'-bis(2-chlorobenzyl)-, dihydrochloride)
 2-Propyn-1-ol (Propargyl alcohol)
 Pyridine
 Radium -226 and -228
 Reserpine (Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[3,4,5-trimethoxybenzoyloxy]-, methyl ester)
 Resorcinol (1,3-Benzenediol)
 Saccharin and salts (1,2-Benzisothiazolin-3-one, 1,1-dioxide, and salts)
 Safrole (Benzene, 1,2-methylenedioxy-4-allyl-)
 Selenious acid (Selenium dioxide)
 Selenium and compounds, N.O.S.*
 Selenium sulfide (Sulfur selenide)
 Selenourea (Carbamimidoseleonic acid)
 Silver and compounds, N.O.S.*
 Silver cyanide
 Sodium cyanide
 Streptozotocin (D-Glucopyranose, 2-deoxy-2-(3-methyl-3-nitro-soureido)-)
 Strontium sulfide
 Strychnine and salts (Strychnidin-10-one, and salts)
 1,2,4,5-Tetrachlorobenzene (Benzene, 1,2,4,5-tetrachloro-)
 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) (Dibenzo-p-dioxin, 2,3,7,8-tetrachloro-)
 Tetrachloroethane, N.O.S.* (Ethane, tetrachloro-, N.O.S.*)
 1,1,1,2-Tetrachlorethane (Ethane, 1,1,1,2-tetrachloro-)
 1,1,2,2-Tetrachlorethane (Ethane, 1,1,2,2-tetrachloro-)
 Tetrachloroethane (Ethane, 1,1,2,2-tetrachloro-)
 Tetrachloromethane (Carbon tetrachloride)
 2,3,4,6-Tetrachlorophenol (Phenol, 2,3,4,6-tetrachloro-)
 Tetraethylthiopyrophosphate (Dithiopyrophosphoric acid, tetraethyl-ester)
 Tetraethyl lead (Plumbane, tetraethyl-)
 Tetraethylpyrophosphate (Pyrophosphoric acid, tetraethyl ester)
 Tetranitromethane (Methane, tetranitro-)
 Thallium and compounds, N.O.S.*
 Thallous oxide (Thallium (III) oxide)
 Thallium (I) acetate (Acetic acid, thallium (I) salt)
 Thallium (I) carbonate (Carbonic acid, dithallium (I) salt)
 Thallium (I) chloride
 Thallium (I) nitrate (Nitric acid, thallium (I) salt)
 Thallium selenite
 Thallium (I) sulfate (Sulfuric acid, thallium (I) salt)
 Thioacetamide (Ethanethioamide)
 Thiosemicarbazide (Hydrazinecarbothioamide)
 Thiourea (Carbamide thio-)
 Thiuram (Bis(dimethylthiocarbonyl) disulfide)
 Thorium and compounds, N.O.S.*, when producing thorium by-product material
 Toluene (Benzene, methyl-)
 Toluenediamine (Diaminotoluene)
 o-Toluidine hydrochloride (Benzenamine, 2-methyl-, hydrochloride)
 Tolyene diisocyanate (Benzene, 1,3-diisocyanatomethyl-)
 Toxaphene (Camphene, octachloro-)
 Tribromomethane (Bromoform)
 1,2,4-Trichlorobenzene (Benzene, 1,2,4-trichloro-)
 1,1,1-Trichloroethane (Methyl chloroform)
 1,1,2-Trichloroethane (Ethane, 1,1,2-trichloro-)

Trichloroethene (Trichloroethylene)
 Trichloromethanethiol (Methanethiol, trichloro-)
 Trichloromonofluoromethane (Methane, trichlorofluoro-)
 2,4,5-Trichlorophenol (Phenol, 2,4,5-trichloro-)
 2,4,6-Trichlorophenol (Phenol, 2,4,6-trichloro-)
 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T) (Acetic acid, 2,4,5-trichlorophenoxy-)
 2,4,5-Trichlorophenoxypropionic acid (2,4,5-TP) (Silvex) (Propionic acid, 2-(2,4,5-trichlorophenoxy)-)
 Trichloropropane, N.O.S.* (Propane, trichloro-, N.O.S.*)
 1,2,3-Trichloropropane (Propane, 1,2,3-trichloro-)
 0,0,0-Triethyl phosphorothioate (Phosphorothioic acid, 0,0,0-triethyl ester)
 sym-Trinitrobenzene (Benzene, 1,3,5-trinitro-)
 Tris(1-aziridinyl) phosphine sulfide (Phosphine sulfide, tris(1-aziridinyl-))
 Tris(2,3-dibromopropyl) phosphate (1-Propanol, 2,3-dibromo-, phosphate)
 Trypan blue (2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'-dimethyl (1,1'-biphenyl)- 4,4'-diyl)bis(azo)]bis(5-amino-4-hydroxy-, tetrasodium salt)
 Uracil mustard (Uracil 5-[bis(2-chloroethyl)amino]-)
 Uranium and compounds, N.O.S.*
 Vanadic acid, ammonium salt (ammonium vanadate)
 Vanadium pentoxide (Vanadium (V) oxide)
 Vinyl chloride (Ethene, chloro-)
 Zinc cyanide
 Zinc phosphide

* The abbreviation N.O.S. (not otherwise specified) signifies those members of the general class not specifically listed by name in this list.

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Reviser's note: The brackets and enclosed material in the text of the above section occurred in the copy filed by the agency.