STATE OF COLORADO

John W. Hickenlooper, Governor Christopher E. Urbina, MD, MPH Executive Director and Chief Medical Officer

Dedicated to protecting and improving the health and environment of the people of Colorado

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Colorado Department of Public Health and Environment

October 30, 2012

Brian E. Holihan, Deputy DirectorDivision of Materials Safety and State AgreementsOffice of Federal and State Materials andEnvironmental Management ProgramsU.S. Nuclear Regulatory CommissionT8-E24Washington, D.C. 20555-0001

Dear Mr. Holihan:

Enclosed is a copy of the <u>draft</u> proposed revisions to the Colorado *Rules and Regulations Pertaining to Radiation Control*, 6 CCR 1007-1, Part 4, titled Standards for Protection Against Radiation. This document has been opened for a 30 day public comment period that began on October 29, 2012. The proposed regulation changes (provided in its entirety) are identified by strike-out text (deletions) and bold text (additions).

The regulatory changes are in response to the following and are summarized in Attachment 1:

- NRC Regulatory Action Tracking System (RATS) Items applicable to Part 4 Table 1
- Programmatic needs and/or clarification Table 2

Proposed regulatory changes were also made as a result of formatting changes to maintain consistency within the document and other Colorado regulatory parts, and to correct minor typographical and cross-reference errors. These items are not specifically identified in a Table. Refer to the attached draft Part 4 for those changes. Note that the tables of Appendix 4B are in a document that is separate and stand-alone from the main body of Part 4.

We believe that the proposed revision satisfies the compatibility and health and safety categories established in the Office of Federal and State Materials and Environmental Management Programs (FSME) Procedure SA-200.

If you have any questions, please feel free to contact me at 303/692-3423 or James Jarvis of my staff at 303/692-3454 or james.jarvis@state.co.us.

Sincerely,

Stephen F. Tarlton, Manager Radiation Program Hazardous Materials and Waste Management Division Enclosures: Attachment 1; Draft B of Part 4; and Draft B of Tables 4B1, 4B2, 4B3. Attachment 1 Brian E. Holihan, Deputy Director U.S. Nuclear Regulatory Commission October 30, 2012 Page 1 of 2

RATs ID	CFR Title	State Section
	2006-2 RATS ITEMS	
2006-2	Appendix E to 10 CFR Part 20	Part 4, Appendix 4G
	Nationally Tracked Source Thresholds	
	2006-3 RATS ITEMS	
2006-3	§20.2207	Part 4, Section 4.55
	Reports of transactions involving nationally	*
	tracked sources.	
	2007-3 RATS ITEMS	
2007-3	§20.2001(a)(4)	Part 4, Section 4.33.1.4
	General requirements (Waste Disposal)	
[Also see NRC		
correspondence dated		
June 28, 2012; and		
October 13, 2011]	(200.000 <i>(</i> ())	D
2007-3	§20.2006(e)	Part 4, Section 4.38.5
[Also see NPC	Transfer for disposal and manifests	
correspondence dated		
June 28, 2012]		
2007-3	\$20.2008	Part 4, Section 4.39.2
	Disposal of certain byproduct material	
[Also see NRC		
correspondence dated		
June 28, 2012]		
2007-3	Appendix B to 10 CFR Part 20	Part 4, Appendix 4B, Tables
5.11	Annual Limits on Intake (ALIs) and Derived Air	4B1, 4B2, 4B3
[Also see NRC	Concentrations (DACs) of Radionuclides for	
October 13, 2011]	Occupational Exposure; Effluent Concentrations;	
October 15, 2011]	Concentrations for Release to Sewerage	
2000.1	2008-1 RATS ITEMS	
2008-1	§20.1201(c)	Part 4, Section 4.6.3.1
	Occupational dose limits for adults	(2)
[Also see Item #2 of NRC		
May 14 20101		
2008-1	820 2205	Part 4 Section 4 57 2
	0-0	1 410 1, 00000011 1.01.4

Table 1. NRC Regulatory Action Tracking System (RATS) Items.

Attachment 1 Brian E. Holihan, Deputy Director U.S. Nuclear Regulatory Commission October 30, 2012 Page 2 of 2

	2011-1 RATS ITEMS	
2011-1	§20.1501(a) General (Surveys and Monitoring)	Part 4, Section 4.17.1
2011-1	§20.1501(b) General (Surveys and Monitoring)	Part 4, Section 4.17.1
2011-1	§20.1403 Criteria for license termination under restricted conditions.	Part 4, Section 4.61.3.3
2011-1	§20.1404(a)(5) Alternate criteria for license termination	Part 4, Section 4.61.4.1(4)

Table 1. NRC Regulatory Action Tracking System (RATS) Items (cont.).

Table 2. Other/non-RATS changes.

CFR Cross-reference	State Section	Description/purpose of proposed change
N/A	Part 4, Section 4.6.3.5	Add reference to NRC RIS 2002-06 in lieu of existing "Webster" equation for multiple dosimetry (during x- ray use).
		The intent is to indicate that the equations of the RIS are acceptable rather than specifying one or more equations within Part 4.
§20.2104	Part 4, Section 4.10	Remove references to lifetime cumulative dose.
		Add additional cross-reference to Planned Special Exposures (PSEs) section similar to that found in 20.2104.
N/A	Part 4, Section 4.15.5	Add clarification pertaining to x-ray program/regulations.
N/A	Part 4, Section 4.19, 4.20	Add clarification pertaining to x-ray program/regulations.
§20.1901	Part 4, Section 4.27.3	Change wording from "shall" to "may", consistent with 20.1901.
§20.1403(a)	Part 4, Section 4.61.3.1	Added language consistent with 20.1403(a) to require consideration of additional detriments when determining whether ALARA criteria/levels have been met for a facility undergoing decommissioning under conditions of restricted use.

1	DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT	
2	Hazardous Materials and Waste Management Division	
3	RADIATION CONTROL - STANDARDS FOR PROTECTION AGAINST RADIATION	
4	6 CCR 1007-1 Part 04	Comment [JJ1]: EDITORIAL NOTE: ALL COMMENTS (SUCH AS THIS ONE) SHOWN IN THE PICHT SIDE MAPCIN OF THIS
5	[Editor's Notes follow the text of the rules at the end of this CCR Document.]	DOCUMENT ARE TO PROVIDE ADDITIONAL INFORMATION AND TO AID THE READER IN
6	PART 4: STANDARDS FOR PROTECTION AGAINST RADIATION	UNDERSTANDING THE PROPOSED CHANGES DURING THE DRAFT REVIEW PROCESS.
7	STANDARDS FOR PROTECTION AGAINST RADIATION	THESE COMMENTS ARE NOT PART OF THE RULE AND ALL COMMENTS WILL BE
8	4.1 Purpose and Scope	DELETED PRIOR TO FINAL SUBMISSION TO THE COLORADO SECRETARY OF STATE'S
9	4.1.1 Authority.	OFFICE FOR FINAL PUBLISHING IN THE COLORADO CODE OF REGULATIONS.
10 11	4.1.1.1 Rules and regulations set forth herein are adopted pursuant to the provisions of Sections 25-1-108, 25-1.5-101(1)(k) and (1)(l), and 25-11-104, CRS.	Comment [JJJ2]: Numbering added/revised throughout Part 4 for purposes of consistency in formatting within the regulatory part.
12	4.1.2 Basis and Purpose.	
13 14	4.1.2.1 A statement of basis and purpose of these regulations is incorporated as part of these regulations; a copy may be obtained from the Department.	
15	4.1.3 Scope.	
16 17	4.1.3.1 This Part 4 establishes standards for protection against ionizing radiation resulting from activities conducted pursuant to licenses or registrations issued by the Department.	
18 19 20 21 22 23	4.1.3.2 The requirements of Part 4 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 Part 4. However, nothing in Part 4 shall be construed as limiting actions that may be necessary to protect health and safety.	
24	4.1.4 Applicability.	
25 26 27 28 29 30	4.1.4.1 Except as specifically provided in other parts of these regulations, Part 4 applies to persons licensed or registered by the Department to receive, possess, use, transfer, or dispose of sources of radiation. The limits in Part 4 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 in accordance with 7.26, or to exposure from voluntary participation in medical research programs.	
31	4.2 Definitions.	(
32	4.2.1 Reserved.	Formatted: Indent: Left: 0"
33	4.3 Implementation.	
34 35	4.3.1 Any existing license or registration condition that is more restrictive than Part 4 remains in force until there is an amendment or renewal of the license or registration.	Formatted: Indent: Left: 0"

36 **4.4 Reserved.**

37 RADIATION PROTECTION PROGRAMS

38 **4.5 Radiation Protection Programs.**

- 4.5.1 Each licensee or registrant shall develop, document, and implement a radiation protection program
 sufficient to ensure compliance with the provisions of Part 4. See 4.41 for recordkeeping
 requirements relating to these programs.
- 42 4.5.2 The licensee or registrant shall use, to the extent practical, procedures and engineering controls
 43 based upon sound radiation protection principles to achieve occupational doses and doses to
 44 members of the public that are as low as is reasonably achievable (ALARA).
- 45 4.5.3 The licensee or registrant shall, at intervals not to exceed 12 months, review the radiation
 46 protection program content and implementation.
- 4.5.4 To implement the ALARA requirements of 4.5.2 and notwithstanding the requirements in 4.14 of
 this part, a constraint on air emissions of radioactive material to the environment, excluding
 radon-222 and its decay products, 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 millisivert (10 mrem) per year from these emissions. If
 a licensee subject to this requirement exceeds this dose constraint, the licensee shall report such
 event as provided in 4.53.2 and promptly take appropriate corrective action to ensure against
 recurrence.

55 OCCUPATIONAL DOSE LIMITS

60 61

62 63

56 **4.6 Occupational Dose Limits for Adults.**

- 4.6.1 The licensee or registrant shall control the occupational dose to individual adults, except forplanned special exposures pursuant to 4.11, to the following dose limits:
- 59 4.6.1.1 An annual limit, which is the more limiting of:
 - The total effective dose equivalent being equal to 0.05 Sv (5 rem); or
 - (2) The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.5 Sv (50 rem).
- 64 4.6.1.2 The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of 65 the extremities, which are:
- 66 (1) A lens dose equivalent of 0.15 Sv (15 rem), and
- 67 (2) A shallow dose equivalent of 0.5 Sv (50 rem) to the skin of the whole body or to the 68 skin of any extremity.
- 4.6.2 Doses received in excess of the annual limits, including doses received during accidents,
 emergencies, and planned special exposures, shall be subtracted from the limits for planned
 special exposures that the individual may receive during the current year and during the
 individual's lifetime. See 4.11.5.1 and 4.11.5.2.
- 73 4.6.3 Assigned dose equivalent.

-		
74	4.6.3.1 When the external exposure is determined by measurement with an external	Formatted: Font: (Default) Arial, 10 pt
75 76 77	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 decimentary method approved by the NPC	Formatted: Normal, Indent: Left: 0.5", Hanging: 0.5"
78 79	4.6.3.21 The assigned deep dose equivalent must be for the part of the body receiving the highest exposure.	Comment [JJ3]: New provision added for consistency with 10 CFR Part 20.1201(c). The added provision clarifies that licensees can still use deep dose equivalent (DDE) in place of
80 81	4.6.3.32 The assigned shallow dose equivalent must be the dose averaged over the contiguous10 square centimeters of skin receiving the highest exposure.	effective dose equivalent (EDE) for the external exposure in demonstrating compliance with the total effective dose equivalent (TEDE) dose limit, consistent with the existing regulatory framework;
82 83 84 85 86	4.6.3.43 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 individual monitoring are unavailable.	however, the DDE must be for the part of the whole body receiving the highest exposure. [The terms DDE, EDE, and TEDE are defined in Part 1 of regulations]. [Refer to the Federal Register, Vol. 72, No. 232, December 4, 2007, page 68043 for additional
87 88 89 90	4.6.3.54 In the case of occupational exposures to x-rays with accelerating voltages of less than 145 kVp and where the worker utilizes lead garment protection, the registrant may calculate the assigned dose equivalent using the following methods discussed in NRC Regulatory Information Summary 2002-06 ¹ , or other methods as approved by the	NRC letter dated 5/4/2010 (Item 2) Compatibility = A RATS 2008-1
91	Department -	Formatted: Font: (Default) Arial, 10 pt
0.0		Formatted: Font: (Default) Arial, 10 pt,
92 93	NRC RIS 2002-06, Evaluating Occupational Dose For Individuals Exposed To NRC-licensed Material And Medical X-Rays,	Formatted: Not Highlight
94 95 96	 (1) Lead apron and no thyroid collar: assigned deep dose equivalent = 0.06 x (collar dose — waist dose) + waist dose (2) Lead apron and thyroid collar: 	Comment [JJ4]: Recently, it was determined that major dosimetry providers do not use or make available the calculation method as shown in the current Part 4. The method shown in this section does not appear to be a method commonly used although its basis can be found in some technical literature.
97	assigned deep dose equivalent = 0.02 x (collar dose — waist dose) + waist dose	The NRC, in a regulatory information summary (RIS 2002-06) describes three accepted calculation methods when there is exposure from both
98 99 100	4.6.4 Derived air concentration (DAC) and annual limit on intake (ALI) values are presented in Table 4B1 of Appendix 4B and may be used to determine the individual's dose and to demonstrate compliance with the occupational dose limits. See 4.46.	radioactive materials and radiation producing machines where personal shielding devices (such as lead aprons/collar shields) are used. The RIS may be found at: http://www.nrc.gov/reading-rm/doc-collections/gen-
101 102 103	4.6.5 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. See footnote 3 of Appendix 4B.	comm/reg-issues/2002/ri02006.pdf The proposed language allows the use described in the RIS as well as other methods to be used when approved by the Department.
104 105 106	4.6.6 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. See 4.10.3.1 and 4.10.5.	There is no equivalent requirement contained in the CFR's. The CRCPD SSRCR Part D (last revised in 2003), contains an equation different than that in the current
107	4.7 Compliance with Requirements for Summation of External and Internal Doses.	Part 4 (shown in strikeout text).
108	4.7.1 If the licensee or registrant is required to monitor pursuant to both 4.18.1 and 4.18.2, the licensee or registrant shall demonstrate compliance with the doce limits by summing external and internal	Formatted: Indent: Left: 0", Hanging: 0.06", Tab stops: 1.06", Left + Not at 1"
110	doses. If the licensee or registrant is required to monitor only pursuant to 4.18.1 or only pursuant	Formatted: Font: 8 pt
111	to 4.18.2, then summation is not required to demonstrate compliance with the dose limits. The	Formatted: Font: 8 pt
112 113	licensee or registrant may demonstrate compliance with the requirements for summation of external and internal doses pursuant to 4.7.2, 4.7.3 and 4.7.4. The dose equivalents for the lens	

114 115	of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.				
116	4.7.2 Intake by Inhalation.				
117 118 119	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:				
120	4.7.2.1 The sum of the fractions of the inhalation ALI for each radionuclide, or				
121 122	4.7.2.2 The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000, or				
123 124 125 126 127 128 129	4.7.2.3 The sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For purposes of this requirement, an organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, W _T , and the committed dose equivalent, H _{T,50} , per unit intake is greater than 10 percent of the maximum weighted value of H ₅₀ , that is, W _T x H _{T,50} , per unit intake for any organ or tissue.				
130	4.7.3 Intake by Oral Ingestion.	_			
131 132 133	4.7.3.1 If the occupationally exposed individual also receives an intake of radionuclides by oral ingestion greater than 10 percent of the applicable oral ALI, the licensee or registrant shall account for this intake and include it in demonstrating compliance with the limits.	d:			
134	4.7.4 Intake through Wounds or Absorption through Skin.				
135 136 137 138	4.7.4.1 The licensee or registrant shall evaluate and, to the extent practical, account for intakes through wounds or skin absorption. The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be evaluated or accounted for pursuant to 4.7.4.	d:			
139	4.8 Determination of External Dose from Airborne Radioactive Material.				
140 141 142	4.8.1 Licensees or registrants 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. See Appendix 4B, footnotes 1 and 2.				
143 144 145 146 147	4.8.2 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.				
148	4.9 Determination of Internal Exposure.				
149 150 151	4.9.1 For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee or registrant shall, when required pursuant to 4.18, take suitable and timely measurements of:				

152 4.9.1.1 Concentrations of radioactive materials in air in work areas; or

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153	4.9.1.2 Quantities of radionuclides in the body; or
154	4.9.1.3 Quantities of radionuclides excreted from the body; or
155	4.9.1.4 Combinations of 4.9.1.1, 4.9.1.2 and 4.9.1.3.
156 157 158	4.9.2 Unless respiratory protective equipment is used, as provided in 4.24, or the assessment of intake is based on bioassays, the licensee or registrant shall assume that an individual inhales radioactive material at the airborne concentration in which the individual is present.
159 160 161	4.9.3 When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior of the material in an individual is known, the licensee or registrant may:
162 163	4.9.3.1 Use that information to calculate the committed effective dose equivalent, and, if used, the licensee or registrant shall document that information in the individual's record; and
164 165 166	4.9.3.2 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
167 168	4.9.3.3 Separately assess the contribution of fractional intakes of Class D, W, or Y compounds of a given radionuclide to the committed effective dose equivalent. See Appendix 4B.
169 170 171 172	4.9.4 If the licensee or registrant chooses to assess intakes of Class Y material using the measurements given in 4.9.1.2 or 4.9.1.3, the licensee or registrant may delay the recording and reporting of the assessments for periods up to 7 months, unless otherwise required by 4.52 or 4.53. This delay permits the licensee or registrant to make additional measurements basic to the assessments.
173 174	4.9.5 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:
175 176	4.9.5.1 The sum of the ratios of the concentration to the appropriate DAC value, that is, D, W, or Y, from Appendix 4B for each radionuclide in the mixture; or
177 178	4.9.5.2 The ratio of the total concentration for all radionuclides in the mixture to the most restrictive DAC value for any radionuclide in the mixture.
179 180 181	4.9.6 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.
182 183	4.9.7 When a mixture of radionuclides in air exists, a licensee or registrant may disregard certain radionuclides in the mixture if:
184 185 186	4.9.7.1 The licensee or registrant uses the total activity of the mixture in demonstrating compliance with the dose limits in 4.6 and in complying with the monitoring requirements in 4.18.2; and
187	4.9.7.2 The concentration of any radionuclide disregarded is less than 10 percent of its DAC; and
188 189	4.9.7.3 The sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30 percent.

190 191	4.9.8 When determining the committed effective dose equivalent, the following information may be considered:	
192 193 194 195	4.9.8.1 In order to calculate the committed effective dose equivalent, the licensee or registrant 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.	
196 197 198 199 200 201 202	4.9.8.2 For an ALI and the associated DAC determined by the nonstochastic organ dose limit of 0.5 Sv (50 rem), the intake of radionuclides that would result in a committed effective dose equivalent of 0.05 Sv (5 rem), that is, the stochastic ALI, is listed in parentheses in Table 4B1 of Appendix 4B. The licensee or registrant may, as a simplifying assumption, use the stochastic ALI to determine committed effective dose equivalent. However, if the licensee or registrant uses the stochastic ALI, the licensee or registrant shall also demonstrate that the limit in 4.6.1.1.2 is met.	
203	4.10 Determination of Prior Occupational Dose.	
204 205	4.10.1 For each individual who is likely to receive, in a year, an occupational dose requiring monitoring pursuant to 4.18, the licensee or registrant shall:	
206	4.10.1.1 D determine the occupational radiation dose received during the current year: and	Formatted: par1
207	4.10.1.2 Attempt to obtain the records of lifetime cumulative occupational radiation dose.	Comment [JJ5]: The proposed change removes a requirement for obtaining lifetime occupational dose for consistency with 10 CFR 20.2104. With the
208 209	4.10.2 Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant shall determine:	lifetime occupational dose is no longer required and was removed from the federal regulatory requirements which became effective in January
210	4.10.2.1 The internal and external doses from all previous planned special exposures; and	2008. Only the occupational radiation dose for the current year is required.
211 212	4.10.2.2 All doses in excess of the limits, including doses received during accidents and emergencies, received during the lifetime of the individual; and	NRC Compatibility = H&S (where planned special exposures are authorized) or D (where PSEs are not authorized)
213	4.10.2.3 All lifetime cumulative occupational radiation dose	Comment [JJ6]: See above comment for 4.10.1.2.
214	4.10.3 In complying with the requirements of 4.10.1 or 4.10.2, a licensee or registrant may:	Comment [JJ7]: The additional reference is
215 216 217 218	4.10.3.1 Accept, as a record of the occupational dose that the individual received during the current year, a written signed statement from the individual, or from the individual's most recent employer for work involving radiation exposure, that discloses the nature and the amount of any occupational dose that the individual received during the current year; and	added for consistency with 10 CFR 20.2104.
219 220 221 222 223	4.10.3.2 Accept, as the record of lifetime-cumulative radiation dose, an up-to-date Department Form R-16, Cumulative Occupational Exposure History, 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	
224 225 226 227 228	4.10.3.3 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, telegram, facsimile, 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.	
229	4.10.4 Record of Exposure History.	

I.		
230	4.10.4.1 The licensee or registrant shall record the exposure history, as require	d by 4.10.1 or
231	required on that form. The form or record shall show each period in which	the individual
233	received occupational exposure to radiation or radioactive material and	shall be signed
234	by the individual who received the exposure. For each period for which i	he licensee or
235	report in preparing Department Form R-16 or equivalent. For any period	in which the
237	licensee or registrant does not obtain a report, the licensee or registrant	shall place a
238 239	notation on Department Form R-16 or equivalent indicating the periods data are not available.	of time for which
240	4.10.4.2 Licensees or registrants are not required to reevaluate the separate ex	ternal dose
241	equivalents and internal committed dose equivalents or intakes of radio	1 1004 Eurthor
242	occupational exposure histories obtained and recorded before January	1, 1994. Puttiel,
244	Department Form R-16 or equivalent, would not have included effective	dose equivalent,
245 246	but may be used in the absence of specific information on the intake of the individual.	adionuclides by
247	4.10.5 If the licensee or registrant is unable to obtain a complete record of an individual	s current and
248	previously accumulated occupational dose, the licensee or registrant shall assur	ne:
249	4.10.5.1 In establishing administrative controls pursuant to 4.6.6 for the current	year, that the
250	for which records were unavailable and the individual was engaged in a	ctivities that could
252	have resulted in occupational radiation exposure; and	
253	4.10.5.2 That the individual is not available for planned special exposures.	
254	4.10.6 The licensee or registrant shall retain the records on Department Form R-16 or e	quivalent until the
255 256	Department terminates each pertinent license or registration requiring this recor registrant shall retain records used in preparing Department Form R-16 or equiv	 The licensee or alent for 3 years
257	after the record is made.	
258	4.11 Planned Special Exposures.	
259	A licensee or registrant may authorize an adult worker to receive doses in additi	on to and
260 261	each of the following conditions in 4.11.1 through 4.11.7 is satisfied:	6 provided that
262	4.11.1 The licensee or registrant authorizes a planned special exposure only in an exce	ptional situation
263	when alternatives that might avoid the dose estimated to result from the planned	l special
264	exposure are unavailable or impractical.	
265	4.11.2 The licensee or registrant, and employer if the employer is not the licensee or re-	gistrant,
266	specifically authorizes the planned special exposure, in writing, before the expos	sure occurs.
267 268	4.11.3 Before a planned special exposure, the licensee or registrant ensures that each involved is:	ndividual
260	444.0.4 Informed of the number of the relevant descentions and	
209	4.11.3.1 informed of the purpose of the planned operation; and	
270 271	4.11.3.2 Informed of the estimated doses and associated potential risks and spelevels or other conditions that might be involved in performing the task;	ecific radiation and

Comment [JJ8]: See prior comment.

272 273	4.11.3.3 Instructed in the measures to be taken to keep the dose ALARA considering other risks that may be present.
274 275 276	4.11.4 Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant ascertains prior doses as required by 4.10.2 during the lifetime of the individual for each individual involved.
277 278 279	4.11.5 Subject to 4.6.2, 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:
280	4.11.5.1 The numerical values of any of the dose limits in 4.6.1 in any year; and
281	4.11.5.2 Five times the annual dose limits in 4.6.1 during the individual's lifetime.
282 283	4.11.6 The licensee or registrant maintains records of the conduct of a planned special exposure in accordance with 4.45 and submits a written report in accordance with 4.54.
284 285 286 287 288	4.11.7 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 30 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 pursuant to 4.6.1 but shall be included in evaluations required by 4.11.4 and 4.11.5.
289	4.12 Occupational Dose Limits for Minors.
290 291	The annual occupational dose limits for minors are 10 percent of the annual occupational dose limits specified for adult workers in 4.6.
292	4.13 Dose Equivalent to an Embryo/Fetus.
293 294 295	4.13.1 The licensee or registrant shall ensure that the dose equivalent to an embryo/fetus during the entire pregnancy, due to the occupational exposure of a declared pregnant woman, does not exceed 5 mSv (0.5 rem). See 4.46 for recordkeeping requirements.
296 297 298	4.13.2 The licensee or registrant shall make efforts to avoid substantial variation ⁴² above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in 4.13.1.
299 300 301	#2 The National Council on Radiation Protection and Measurements recommended in NCRP Report No. 91 "Recommendations on Limits for Exposure to Ionizing Radiation" (June 1, 1987) that no more than 0.5 mSv (0.05 rem) to the embryo/fetus be received in any one month. Comment [JJ9]: Footnote renumb of new footnote in 4.6.3.5.
302	4.13.3 The dose equivalent to an embryo/fetus is the sum of:
303	4.13.3.1 The deep dose equivalent to the declared pregnant woman; and
304 305	4.13.3.2 The dose equivalent to the embryo/fetus resulting from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.
306	4.13.4. If the dose equivalent to the embry offectus is found to have exceeded 5 mSy (0.5 rem) or is within

306 307 308 309 310 If the dose equivalent to the embryo/fetus is found to have exceeded 5 mSv (0.5 rem), or is within 0.5 mSv (0.05 rem) of this dose, by the time the woman declares the pregnancy to the licensee or registrant, the licensee or registrant shall be deemed to be in compliance with 4.13.1 if the additional dose equivalent to the embryo/fetus does not exceed 0.5 mSv (0.05 rem) during the remainder of the pregnancy.

bered as a result

311	RADIATION DOSE LIMITS FOR INDIVIDUAL MEMBERS OF THE PUBLIC	
312	4.14 Dose Limits for Individual Members of the Public.	
313	4.14.1 Each licensee or registrant shall conduct operations so that:	
314 315 316 317 318 319 320	4.14.1.1 The total effective dose equivalent to individual members of the public from the licensed or registered operation does not exceed 1 millisievert (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 in accordance with 7.26, from voluntary participation in medical research programs, and from the dose contribution from the licensee's or registrant's disposal of radioactive material into sanitary sewerage in accordance with 4.35, and	
321 322 323	4.14.1.2 The dose in any unrestricted area from external sources, exclusive of the dose contributions from patients administered radioactive material and released in accordance with 7.26, does not exceed 0.02 millisievert (0.002 rem) in any one hour.	
324 325	4.14.2 A licensee may permit visitors to an individual who cannot be released under 7.26 to receive a radiation dose greater than 1 mSv (0.1 rem) if:	
326	4.14.3.1 The radiation dose received does not exceed 5 mSv (0.5 rem); and	
327 328	4.14.3.1 The authorized user, as defined in Part 7, has determined before the visit that it is appropriate.	
329 330 331	4.14.3 A licensee, registrant, or an applicant for a license or registration may apply for prior Department authorization to operate up to an annual dose limit for an individual member of the public of 5 mSv (0.5 rem). This application shall include the following information:	
332 333	4.14.3.1 Demonstration of the need for and the expected duration of operations in excess of the limit in 4.14.1; and	
334 335	4.14.3.2 The licensee's or registrant's program to assess and control dose within the 5 mSv (0.5 rem) annual limit; and	
336	4.14.3.3 The procedures to be followed to maintain the dose ALARA.	
337 338 339	4.14.4 In addition to the requirements of Part 4, a licensee or registrant subject to the provisions of the U.S. Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190 (July 1, 2004) shall comply with those standards.	
340 341 342	4.14.5 The Department may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee or registrant may release in effluents in order to restrict the collective dose.	

343 4.15 Compliance with Dose Limits for Individual Members of the Public.

- 344 345 346 4.15.1 The licensee or registrant 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 4.14.
- 347 4.15.2 A licensee or registrant shall show compliance with the annual dose limit in 4.14 by:

348 349 350	4.15.2.1 Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed or registered operation does not exceed the annual dose limit; or	
351	4.15.2.2 Demonstrating that:	
352 353 354	(1) 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 4B2 of Appendix 4B; and	
355 356 357	(2) 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 0.5 mSv (0.05 rem) in a year.	
358 359 360 361	4.15.3 Upon approval from the Department, the licensee or registrant may adjust the effluent concentration values in Appendix 4B, Table 4B2, 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.	
362 363 364 365 366 367	4.15.4 Rooms or areas in which diagnostic x-ray systems are the only source of radiation shall demonstrate compliance with 4.15.2.1 after construction of a new x-ray facility, after modification or renovation of an existing x-ray facility, or installation or a new x-ray machine in an existing x-ray facility when there is a change in primary beam orientation, or a change in primary shielding due to the modification or renovation of a facility, or where there is a projected increase in the x-ray workload from that which was used for a prior x-ray shielding design.	
368 369 370	4.15.5 Rooms Facilities or areas in whichusing only dental intraoral, ordental panoramic, mini-c-arm x-ray, or bone densitometry systemsmachines in single occupancy rooms are used, are exempt from the requirements of 4.15.2.1.	Comment [JJ10]: The proposed changes are
371	TESTING FOR LEAKAGE OR CONTAMINATION OF SEALED SOURCES	made at the request of the X-ray Certification Unit for clarification purposes and consistency with similar requirements found in Part 6, Section 6.3.2.4.
372	4.16 Testing for Leakage or Contamination of Sealed Sources.	Language related to single occupancy rooms was deleted from Part 6 during a prior revision to that
373	4.16.1 The licensee or registrant in possession of any sealed source shall assure that:	Part. The deletion of this language here in Part 4 is to maintain consistency between regulatory Parts.
374 375 376	4.16.1.1 Each sealed source, except as specified in 4.16.2, is tested for leakage or contamination and the test results are received before the sealed source is put into use unless the licensee or registrant has a certificate from the transferor indicating that the	As this provision pertains to radiation machines, there is no NRC compatibility issue associated with it.
377 378 379	sealed source was tested within 6 months before transfer to the licensee or registrant. Sources that indicate contamination in excess of 185 Bq (0.005 microcuries) shall not be put into use.	
380 381	4.16.1.2 Each sealed source that is not designed to emit alpha particles is tested for leakage or contamination at intervals not to exceed 6 months or at alternative intervals approved by	
382 383 384	the Department, after evaluation of information specified by 3.12.12.24 and 3.12.12.35 of these regulations, an Agreement State, a Licensing State, or the U.S. Nuclear Regulatory Commission.	Comment [JJ11]: During a prior revision to Part 3, the sections originally referenced here were deleted/renumbered. The proposed change corrects the mis-referenced sections.
385 386 387	4.16.1.3 Each sealed source that is designed to emit alpha particles is tested for leakage or contamination at intervals not to exceed 3 months or at alternative intervals approved by the Department, after evaluation of information specified by 3.12.12.24 and 3.12.12.85 of	The Part 3 sections referenced here are parallel to those found in 10 CFR 32.51(b).
388 389	these regulations, an Agreement State, a Licensing State, or the U.S. Nuclear Regulatory Commission.	Comment [JJ12]: Same as above comment.

390 391 392 393		4.16.1.4 For each sealed source that is required to be tested for leakage or contamination, at any other time there is reason to suspect that the sealed source might have been damaged or might be leaking, the licensee or registrant shall assure that the sealed source is tested for leakage or contamination before further use.	
394 395 396 397 398 399 400		4.16.1.5 Tests, and evaluations of tests, for leakage for all sealed sources, except brachytherapy sources manufactured to contain radium, shall be capable of detecting the presence of 185 Bq (0.005 μCi) of radioactive material on a test sample. Test samples shall be take n from the sealed source or from the surfaces of the container in which the sealed source is stored or mounted on which one might expect contamination to accumulate. For a sealed source contained in a device, test samples are obtained when the source is in the "off" position.	
401 402		4.16.1.6 The test for leakage for brachytherapy sources manufactured to contain radium shall be capable of detecting an absolute leakage rate of 37 Bg (0.001 µCi) of radon-222 in a 24-	
403 404		hour period when the collection efficiency for rado $\frac{1}{n}$ -22 and its decay products has been determined with respect to collection method, volume and time.	Comment [JJ13]: Removed extra space.
405 406 407 408		4.16.1.7 Tests for contamination from radium decay products shall be taken on the interior surface of brachytherapy source storage containers and shall be capable of detecting the presence of 185 Bq (0.005 μ Ci) of a radium decay product which has a half-life greater than 4 days.	
409 410	4.16.2	A licensee or registrant need not perform test for leakage or contamination on the following sealed sources:	
411		4.16.2.1 Sealed sources containing only radioactive material with a half-life of less than 30 days;	
412		4.16.2.2 Sealed sources containing only radioactive material as a gas;	
413 414		4.16.2.3 Sealed sources containing 3.7 MBq (100 μ Ci) or less of beta or photon-emitting material or 370 kBq (10 μ Ci) or less of alpha-emitting material;	
415		4.16.2.4 Sealed sources containing only hydrogen-3;	
416		4.16.2.5 Seeds of iridium-192 encased in nylon ribbon; and	
417 418 419 420 421		4.16.2.6 Sealed sources, except teletherapy and brachytherapy sources, which are stored, not being used and identified as in storage. The licensee or registrant shall, however, test each such sealed source for leakage or contamination and receive the test results before any use or transfer unless it has been tested for leakage or contamination within 6 months before the date of use or transfer.	
422 423 424	4.16.3	Tests for leakage or contamination from sealed sources shall be performed by persons specifically authorized by the Department, an Agreement State, a Licensing State, or the U.S. Nuclear Regulatory Commission to perform such services.	
425 426	4.16.4	Test results shall be kept in units of becquerel (or microcurie) and maintained for inspection by the Department.	
427	4.16.5	The following shall be considered evidence that a sealed source is leaking:	
428 429		4.16.5.1 T he presence of 185 Bq (0.005 μCi) or more of removable contamination on any test sample.	

430 431	4.16.5.2 Leakage of 37 Bq (0.001 μCi) of radon-222 per 24 hours for brachytherapy sources manufactured to contain radium.	
432 433	4.16.5.3 The presence of removable contaminat-ion resulting from the decay of 185 Bq (0.005 $\mu\text{Ci})$ or more of radium.	
434 435 436	4.16.6 The licensee or registrant shall immediately withdraw a leaking sealed source from use and shall take action to prevent the spread of contamination. The leaking sealed source shall be repaired or disposed of in accordance with this Part.	
437	4.16.7 Reports of test results for leaking or contaminated sealed sources shall be made pursuant to 4.58.	
438	SURVEYS AND MONITORING	
439	4.17 General.	
440 441	4.17.1 Each licensee or registrant shall make, or cause to be made, surveys of areas, including the subsurface, that:	Comment [JJ14]: Language added for
442	4.17.1.1 Are necessary for the licensee or registrant to comply with Part 4; and	consistency with 10 CFR Part 20.1501(a). The requirement adds language to indicate that
443	4.17.1.2 Are necessary under the circumstances to evaluate:	as part of the routine radiological safety program along with other surveys where subsurface
444	(1) The magnitude and extent of radiation levels; and	contamination is <u>known to exist</u> . Where no subsurface contamination is known to exist then no additional survey are required
445	(2) Concentrations or quantities of radioactive material; and	The intent of this provision is to prevent future issues
446 447	(3) The potential radiological hazards.	related to decommissioning problems. NRC RATS = 2011-1, Item 4
448 449	4.17.2 Notwithstanding 4.42.1, records from surveys describing the location and amount of	Compatibility = H&S (Due date for state adoption 12/2015)
450 451	for decommissioning, and such records must be retained in accordance with 3.16.5, as	Formatted: Indent: Left: 0", Hanging: 0.5"
431	appricable.	Formatted: Font: 10 pt
452	4.17.3 The licensee or registrant shall ensure that instruments and equipment used for quantitative	Comment [JJ15]: Language added for consistency with 10 CFR Part 20.1501(b).
455	intervals not to exceed 12 months for the radiation measured unless otherwise noted in these	This is a new requirement related to the revised
455	regulations.	language of 4.17.1. The requirement adds language to indicate that records pertaining to subsurface
156	4.17.43 All personnel designators, except for direct and indirect reading packet ionization chambers and	residual radioactivity must be maintained along with
457	those dosimeters used to measure the dose to any extremity, that require processing to	other surveys pertaining to decommissioning where subsurface contamination is <u>known</u> to exist.
458	determine the radiation dose and that are used by licensees and registrants to comply with 4.6,	NRC RATS = 2011-1. Item 5
459	with other applicable provisions of these regulations, or with conditions specified in a license or registration shall be processed and evaluated by a dosimetry processor:	Compatibility = H&S (Due date for state adoption 12/2015)
461	4.17.34.1 Holding current personnel dosimetry accreditation from the National Voluntary	
462 463	Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology; and	
464	4.17.34.2 Approved in this accreditation process for the type of radiation or radiations included in	
403 466	which the individual wearing the dosimeter is monitored.	
467 468	4.17.54 The licensee or registrant shall ensure that adequate precautions are taken to prevent a deceptive exposure of an individual monitoring device.	

469	4.18 Conditions Requiring Individual Monitoring of External and Internal Occupational Dose.
470 471	Each licensee or registrant shall monitor exposures from sources of radiation at levels sufficient to demonstrate compliance with the occupational dose limits of Part 4. As a minimum:
472 473 474	4.18.1 Each licensee or registrant shall monitor occupational exposure to radiation from licensed and unlicensed radiation sources under the control of the licensee and shall supply and require the use of individual monitoring devices by:
475 476	4.18.1.1 Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in 4.6.1;
477 478 479 480	4.18.1.2 Minors likely to receive, in 1 year from radiation sources external to the body, a deep dose equivalent in excess of 1mSv (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 5 mSv (0.5 rem);
481 482 483 484	 4.18.1.3 Declared pregnant women likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent in excess of 1mSv (0.1 rem)²³; and 23 All of the occupational doses in 4.6 continue to be applicable to the declared pregnant worker as long as the embryo/fetus dose
485	limit is not exceeded.
486	4.18.1.4 Individuals entering a high radiation area or a very high radiation area.
487 488	4.18.2 Each licensee or registrant shall monitor, to determine compliance with 4.9, the occupational intake of radioactive material by and assess the committed effective dose equivalent to:
489 490	4.18.2.1 Adults likely to receive, in 1 year, an intake in excess of 10 percent of the applicable ALI(s) in Table 4B1, Columns 1 and 2, of Appendix 4B;
491 492	4.18.2.2 Minors likely to receive, in 1 year, a committed effective dose equivalent in excess of 1 mSv (0.1 rem); and
493 494	4.18.2.3 Declared pregnant women likely to receive during the entire pregnancy, a committed effective dose equivalent in excess of 1 mSv (0.1 rem).
495 496	4.18.3 Upon approval of the Department, an acceptable alternative to the use of continuous individual monitoring devices in order to demonstrate compliance with 4.18.1 and 4.18.2 may be used.
497 498	4.18.3.1 Acceptable alternative demonstrations that doses will not exceed 10 percent of the annual limits in 4.6.1, 4.12 and 4.13 include submittal to the Department of:
499 500	 (1) An acceptable application documenting six months of the use of continuous individual monitoring devices; or
501 502 503	(2) An acceptable assessment from a qualified expert, as defined in 1.24, that takes into account design configuration, workload, radiation-producing machine output, and survey data.
504 505	4.18.3.2 To maintain approval of an acceptable alternative to the use of continuous individual monitoring devices:
506 507	 Reapplication under 4.18.3.1(1) or reassessment under 4.18.3.1(2) is required for any change in configuration, equipment or workload; and

508 509	(2) The licensee or registrant shall include assessment of individual monitoring in the review of the radiation protection program required annually by 4.5.			
510	CONTROL OF EXPOSURE FROM EXTERNAL SOURCES IN RESTRICTED AREAS			
511	4.19 Control of Access to High Radiation Areas.			
512 513	4.19.1 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:			
514 515 516 517	4.19.1.1 A control device that, upon entry into the area, causes the level of radiation to be reduced below that level at which an individual might receive a deep dose equivalent of 1 mSv (0.1 rem) in 1 hour at 30 centimeters from the source of radiation from any surface that the radiation penetrates; or			
518 519 520	4.19.1.2 A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or			
521 522	4.19.1.3 Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.			
523 524 525	4.19.2 In place of the controls required by 4.19.1 for a high radiation area, the licensee or registrant may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry.			
526 527	4.19.3 The licensee or registrant may apply to the Department for approval of alternative methods for controlling access to high radiation areas.			
528 529	4.19.4 The licensee or registrant shall establish the controls required by 4.19.1 and 4.19.3 in a way that does not prevent individuals from leaving a high radiation area.			
530 531 532 533	4.19.5 The licensee or registrant is not required to control each entrance or access point to a room or other area that is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled in accordance with the regulations of the U.S. Department of Transportation provided that:			
534	4.19.5.1 The packages do not remain in the area longer than 3 days; and			
535 536	4.19.5.2 The dose rate at 1 meter from the external surface of any package does not exceed 0.1 mSv (0.01 rem) per hour.			
537 538 539 540 541 542	4.19.6 The licensee or registrant is not required to control entrance or access to rooms or other areas in hospitals solely because of the presence of patients containing radioactive material, provided that there are personnel in attendance who are taking the necessary precautions to prevent the exposure of individuals to radiation or radioactive material in excess of the established limits in Part 4 and to operate within the ALARA provisions of the licensee's or registrant's radiation protection program.			
543 544 545 546 547	4.19.7 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 high radiation area as described in 4.19 if the licensee or registrant has met all the specific requirements for access and control specified in other applicable parts of these regulations, such as, Part 5 for industrial radiography, Part 6 for x-rays in the healing arts, and Part 9 for particle accelerators not used in the healing arts.			

Comment [JJ17]: Language is added for clarity, as there are separate regulatory Parts for particle accelerators used in healing arts and non-healing arts applications. Only the non-healing arts application of particle accelerators are exempt from 4.19.7., since other requirements are specified in Part 9.

548 **4.20** Control of Access to Very High Radiation Areas.

549	4.20.1 In addition to the requirements in 4.19, the licensee or registrant shall institute measures to
550	ensure that an individual is not able to gain unauthorized or inadvertent access to areas in which
551	radiation levels could be encountered at 5 Gy (500 rad) or more in 1 hour at 1 meter from a
552	source of radiation or any surface through which the radiation penetrates. This requirement does
553	not apply to rooms or areas in which diagnostic x-ray systems are the only source of radiation, or
554	to non-self-shielded irradiators.

4.20.2 The registrant is not required to control entrance or access to rooms or other areas containing
sources of radiation capable of producing a very high radiation area as described in 4.20.1 if the
registrant has met all the specific requirements for access and control specified in other
applicable parts of these regulations, such as, Part 5 for industrial radiography, Part 6 for x-rays
in the healing arts, and Part 9 for particle accelerators not used in the healing arts.

560 4.21 Control of Access to Very High Radiation Areas - Irradiators.

561 562 563 564 565 566	4.21.1 Section 4.21 applies to licensees or registrants with sources of radiation in non-self-shielded irradiators. Section 4.21 does not apply to sources of radiation that are used in teletherapy, in industrial radiography, or in completely self-shielded irradiators in which the source of radiation is both stored and operated within the same shielding radiation barrier and, in the designed configuration of the irradiator, is always physically inaccessible to any individual and cannot create high levels of radiation in an area that is accessible to any individual.
567 568 569	4.21.2 Each area in which there may exist radiation levels in excess of 5 Gy (500 rad) in 1 hour at 1 meter from a source of radiation that is used to irradiate materials shall meet the following requirements:
570	4.21.2.1 Each entrance or access point shall be equipped with entry control devices which:
571	 (1) Function automatically to prevent any individual from inadvertently entering a very
572	high radiation area; and
573	(2) Permit deliberate entry into the area only after a control device is actuated that
574	causes the radiation level within the area, from the source of radiation, to be
575	reduced below that at which it would be possible for an individual to receive a
576	deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and
577	(3) Prevent operation of the source of radiation if it would produce radiation levels in the
578	area that could result in a deep dose equivalent to an individual in excess of 1
579	mSv (0.1 rem) in 1 hour.
580 581	4.21.2.2 Additional control devices shall be provided so that, upon failure of the entry control devices to function as required by 4.21.2.1:
582	(1) The radiation level within the area, from the source of radiation, is reduced below that
583	at which it would be possible for an individual to receive a deep dose equivalent
584	in excess of 1 mSv (0.1 rem) in 1 hour; and
585	(2) Conspicuous visible and audible alarm signals are generated to make an individual
586	attempting to enter the area aware of the hazard and at least one other
587	authorized individual, who is physically present, familiar with the activity, and
588	prepared to render or summon assistance, aware of the failure of the entry
589	control devices.

Comment [JJ18]: Language is added for clarity, as there are separate regulatory Parts for particle accelerators used in healing arts and non-healing arts applications. Only the non-healing arts application of particle accelerators are exempt from 4.20.2., since other requirements are specified in Part 9.

590 591	4.21.2.3 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:		
592 593 594	(1) The radiation level from the source of radiation is reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and		
595 596 597 598	(2) 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 familiar with the activity and prepared to render or summon assistance, aware of the failure or removal of the physical barrier.		
599 600 601	4.21.2.4 When the shield for stored sealed sources is a liquid, the licensee or registrant shall provide means to monitor the integrity of the shield and to signal, automatically, loss of adequate shielding.		
602 603 604	4.21.2.5 Physical radiation barriers that comprise permanent structural components, such as walls, that have no credible probability of failure or removal in ordinary circumstances need not meet the requirements of 4.21.2.3 and 4.21.2.4.		
605 606 607 608 609	4.21.2.6 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.		
610 611 612	4.21.2.7 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.		
613 614 615 616	4.21.2.8 Each area shall be checked by a radiation measurement to ensure that, prior to the first individual's entry into the area after any use of the source of radiation, the radiation level from the source of radiation in the area is below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour.		
617 618	4.21.2.9 The entry control devices required in 4.21.2.1 shall be tested for proper functioning. See4.49 for recordkeeping requirements.		
619 620	(1) Testing shall be conducted prior to initial operation with the source of radiation on any day, unless operations were continued uninterrupted from the previous day; and		
621 622	(2) Testing shall be conducted prior to resumption of operation of the source of radiation after any unintentional interruption; and		
623 624	(3) The licensee or registrant shall submit and adhere to a schedule for periodic tests of the entry control and warning systems.		
625 626 627	4.21.2.10 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.		
628 629 630 631	4.21.2.11 Entry and exit portals that are used in transporting materials to and from the irradiation area, and that are not intended for use by individuals, 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		

632 materials shall be equipped to detect and signal the presence of any loose radioactive 633 material that is carried toward such an exit and to automatically prevent loose radioactive 634 material from being carried out of the area. 635 4.21.3 Licensees, registrants, or applicants for licenses or registrations for sources of radiation within the purview of 4.21.2 which will be used in a variety of positions or in locations, such as open fields or 636 637 forests, that make it impracticable to comply with certain requirements of 4.21.2, such as those 638 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 639 640 least equivalent to those specified in 4.21.2. At least one of the alternative measures shall include 641 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 642 643 sources of radiation are used.

644 4.21.4 The entry control devices required by 4.21.2 and 4.21.3 shall be established in such a way that no
 645 individual will be prevented from leaving the area.

646 RESPIRATORY PROTECTION AND CONTROLS TO RESTRICT INTERNAL EXPOSURE IN 647 RESTRICTED AREAS

648 4.22 Use of Process or Other Engineering Controls.

649The licensee shall use, to the extent practical, process or other engineering controls, such as650containment, decontamination or ventilation, to control the concentrations of radioactive material651in air.

652 4.23 Use of Other Controls.

- 4.23.1 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:
- 657 4.23.1.1 Control of access; or
- 658 4.23.1.2 Limitation of exposure times; or
- 659 4.23.1.3 Use of respiratory protection equipment; or
- 660 4.23.1.4 Other controls.
- 4.23.2 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.

664 **4.24 Use of Individual Respiratory Protection Equipment.**

- 665 4.24.1 If the licensee uses respiratory protection equipment to limit intakes pursuant to 4.23:
- 4.24.1.1 Except as provided in 4.24.1.2, the licensee shall use only respiratory protection
 equipment that is tested and certified or had certification extended by the National
 Institute for Occupational Safety and Health and the Mine Safety and Health
 Administration.

670 671 672 673 674 675 676 677 678	4.24.1.2 If the licensee wishes to use equipment that has not been tested or certified by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration, or has not had certification extended by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration, or for which there is no schedule for testing or certification, the licensee shall submit an application for authorized use of that equipment, including a demonstration by testing, or a demonstration on the basis of reliable test information, that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use.
679 680	4.24.1.3 The licensee shall implement and maintain a respiratory protection program that includes:
681 682	(1) Air sampling sufficient to identify the potential hazard, permit proper equipment selection, and estimate exposures; and
683	(2) Surveys and bioassays, as appropriate, to evaluate actual intakes; and
684 685	(3) Testing of respirators for operability (user seal check for face sealing devices and functional check for others) immediately prior to each use; and
686 687 688 689 690 691	(4) Written procedures regarding selection, fitting, issuance, maintenance, repair, quality assurance, storage and testing of respirators, including testing for operability immediately prior to each use; supervision and training of personnel; limitations on periods of respirator use and relief from respirator use; breathing air quality; monitoring, including air sampling and bioassays; inventory, control and recordkeeping; and
692 693 694 695	(5) Determination by a physician, prior to initial fitting of respirators, before the first field use of non-face-sealing respirators, and either every 12 months thereafter or periodically at a frequency determined by a physician, that the individual user is medically fit to use the respiratory protection equipment.
696 697 698 699 700 701	(6) Fit testing, with fit factor 10 times the assigned protection factor (APF) for negative pressure devices, and a fit factor greater than or equal to 500 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 1 year. Fit testing must be performed with the facepiece operating in the negative pressure mode.
702	4.24.1.4 The licensee shall:
703	(1) Issue a written policy statement on respirator usage covering:
704	(a) The use of process or other engineering controls, instead of respirators; and
705	(b) The routine, nonroutine, and emergency use of respirators; and
706	(c) The length of periods of respirator use and relief from respirator use; and
707 708 709 710 711	(2) Advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other conditions that might require such relief.

712 713 714 715 716	4.24.1.5 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.
717 718 719 720 721 722 723 724 725 726 727	4.24.1.6 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.
728 729 730 731 732	 4.24.1.7 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," edition 5, published August 27, 2004, and included in the regulations of the Occupational Safety And Health Administration (29 CFR 1910.134(i)(1)(ii)(A) through (E), July 1, 2004).
733	Grade D quality air criteria include:
734	(1) Oxygen content (V/V) between 19.5 per cent and 23.5 per cent;
735	(2) Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;
736	(3) Carbon monoxide (CO) content of 10 parts per million or less;
737	(4) Carbon dioxide content of 1,000 parts per million or less; and
738	(5) Lack of noticeable odor.
739 740 741 742	4.24.1.8 The licensee shall ensure that no objects, materials or substances, such as facial hair, or any conditions that interfere with the face, 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.
743 744 745 746 747 748	4.24.1.9 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.
749 750 751	4.24.2 When estimating exposure of individuals to airborne radioactive materials, the licensee may make allowance for respiratory protection equipment used to limit intakes pursuant to 4.23, provided that the following conditions, in addition to those in 4.24.1, are satisfied:
752 753 754	4.24.2.1 The licensee selects respiratory protection equipment that provides a protection factor, specified in Appendix 4A, greater than the multiple by which peak concentrations of airborne radioactive materials in the working area are expected to exceed the values

755 756 757 758 759 760 761 762 763 764 765	specified in Appendix 4B, Table 4B1, Column 3. However, if the selection of respiratory protection equipment with a protection factor greater than the multiple defined in the preceding sentence is inconsistent with the goal specified in 4.23 of keeping the total effective dose equivalent ALARA, the licensee may select respiratory protection equipment with a lower protection factor provided that such a selection would result in a total effective dose equivalent that is ALARA. The concentration of radioactive material in the air that is inhaled when respirators are worn may be initially estimated by dividing the average concentration in air, during each period of uninterrupted use, by the protection factor. If the exposure is later found to be greater than initially estimated, the corrected value shall be used; if the exposure is later found to be less than initially estimated, the
766 767 768 769	4.24.2.2 The licensee shall obtain authorization from the Department before assigning respiratory protection factors in excess of those specified in Appendix 4A. The Department may authorize a licensee to use higher protection factors on receipt of an application that:
770	(1) Describes the situation for which a need exists for higher protection factors, and
771 772	(2) Demonstrates that the respiratory protection equipment provides these higher protection factors under the proposed conditions of use.
773 774 775 776	4.24.3 In an emergency, the licensee shall use as emergency equipment only respiratory protection equipment that has been specifically certified or had certification extended for emergency use by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration.
777 778	4.24.4 The licensee shall notify the Department in writing at least 30 days before the date that respiratory protection equipment is first used pursuant to either 4.24.1 or 4.24.2.
779 780	4.24.5 The Department may impose restrictions in addition to the provisions of 4.23.2, 4.24.1, and Appendix 4A, in order to:
781 782 783	4.24.5.1 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
784 785	4.24.5.2 Limit the extent to which a licensee may use respiratory protection equipment instead of process or other engineering controls.
786	STORAGE AND CONTROL OF LICENSED OR REGISTERED SOURCES OF RADIATION
787	4.25 Security of Stored Sources of Radiation.
788 789	4.25.1 The licensee shall secure from unauthorized removal or access licensed or registered sources of radiation that are stored in unrestricted areas.
790	4.25.2 Security requirements for portable gauges.
791 792 793	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.
794	4.26 Control of Sources of Radiation not in Storage.

- 4.26.1 The licensee shall control and maintain constant surveillance of licensed or registered radioactive
 material that is in an unrestricted area and that is not in storage or in a patient.
- 4.26.2 The registrant shall maintain control of radiation machines that are in an unrestricted area and that
 are not in storage.
- 799 PRECAUTIONARY PROCEDURES

800 **4.27 Caution Signs.**

4.27.1 Standard Radiation Symbol. Unless otherwise authorized by the Department, the symbol
 prescribed by 4.27 shall use the colors magenta, or purple, or black on yellow background. The
 symbol prescribed is the three-bladed design as follows:

804 RADIATION SYMBOL

- 805 4.27.1.1. Cross-hatched area is to be magenta, or purple, or black, and
- 806 4.27.1.2. The background is to be yellow.
- 807 Radiation Symbol
- 808 6CCR1007-1_RadiationSymbol.jpg
- 809 4.27.2 Exception to Color Requirements for Standard Radiation Symbol.
- 810 Notwithstanding the requirements of 4.27.1, licensees or registrants are authorized to label
 811 sources, source holders, or device components containing sources of radiation that are subjected
 812 to high temperatures, with conspicuously etched or stamped radiation caution symbols and
 813 without a color requirement.
- 814 4.27.3 Additional Information on Signs and Labels.
- 815 In addition to the contents of signs and labels prescribed in Part 4, the licensee mayshall provide,
 816 on or near the required signs and labels, additional information, as appropriate, to make
 817 individuals aware of potential radiation exposures and to minimize the exposures.
- 818 4.28 Posting Requirements.
- 819 4.28.1 Posting of Radiation Areas.
- 820The licensee or registrant shall post each radiation area with a conspicuous sign or signs bearing
the radiation symbol prescribed in 4.27 and the words "CAUTION, RADIATION AREA."
- 822 4.28.2 Posting of High Radiation Areas.
- 823The licensee or registrant shall post each high radiation area with a conspicuous sign or signs824bearing the radiation symbol prescribed in 4.27 and the words "CAUTION, HIGH RADIATION825AREA" or "DANGER, HIGH RADIATION AREA."
- 826 4.28.3 Posting of Very High Radiation Areas.
- 827The licensee or registrant shall post each very high radiation area with a conspicuous sign or828signs bearing the radiation symbol prescribed in 4.27 and words "GRAVE DANGER, VERY829HIGH RADIATION AREA."
- 830 4.28.4 Posting of Airborne Radioactivity Areas.

Comment [JJ19]: EDITORIAL NOTE: There is no change to this provision. This symbol will remain in Part 4 as shown in the current/official Part 4 as maintained by the Colorado Secretary of State. During translation/download from the SOS website used to produce the proposed changes (this document), the symbol was not included.

Comment [JJ20]: The proposed change is consistent with the current language in 10 CFR 20.1901, and CRCDPD SSRCR Part D (2003) – both of which use "may". The proposed change is at the suggestion of an external stakeholder.

The basis for proposing a change from a mandatory "shall" to a "may" is that without specific criteria or examples on what the additional information "shall" be, there is difficulty in establishing compliance with this provision.

- 831 The licensee or registrant shall post each airborne radioactivity area with a conspicuous sign or 832 signs bearing the radiation symbol prescribed in 4.27 and the words "CAUTION, AIRBORNE 833 RADIOACTIVITY AREA" or "DANGER. AIRBORNE RADIOACTIVITY AREA." 834 4.28.5 Posting of Areas or Rooms in which Licensed or Registered Material is Used or Stored. 835 The licensee or registrant shall post each area or room in which there is used or stored an 836 amount of licensed or registered material exceeding 10 times the quantity of such material specified in Appendix 4C with a conspicuous sign or signs bearing the radiation symbol 837 838 prescribed in 4.27 and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, 839 RADIOACTIVE MATERIAL(S). 840 4.29 Exceptions to Posting Requirements. 841 4.29.1 A licensee or registrant is not required to post caution signs in areas or rooms containing sources 842 of radiation for periods of less than 8 hours, if each of the following conditions is met: 4.29.1.1 The sources of radiation are constantly attended during these periods by an individual 843 who takes the precautions necessary to prevent the exposure of individuals to sources of 844 845 radiation in excess of the limits established in Part 4; and 846 4.29.1.2 The area or room is subject to the licensee's or registrant's control. 847 4.29.2 Rooms or other areas in hospitals that are occupied by patients are not required to be posted with 848 caution signs pursuant to 4.28 provided that the total effective dose equivalent to individual 849 members of the public from the patient does not exceed 1 millisievert (0.1 rem) in a year. 850 4.29.3 A room or area is not required to be posted with a caution sign because of the presence of a
 - 4.29.5 A room of area is not required to be posted with a caddion sign because of the presence of a
 sealed source provided the radiation level at 30 centimeters from the surface of the sealed source
 container or housing does not exceed 0.05 mSv (0.005 rem) per hour.
 - 8534.29.4 Rooms in hospitals or clinics that are used for teletherapy are exempt from the requirement to854post caution signs under 4.28 if:
 - 855 4.29.4.1 Access to the room is controlled pursuant to 7.52; and
 - 4.29.4.2 Personnel in attendance take necessary precautions to prevent the inadvertent
 exposure of workers, other patients, and members of the public to radiation in excess of
 the limits established in this part.
 - 4.29.5 A room or area is not required to be posted with a caution sign because of the presence
 of radiation machines used solely for diagnosis in the healing arts.

861 **4.30** Labeling Containers and Radiation Machines.

4.30.1 The licensee or registrant shall ensure that each container of licensed or registered material bears a durable, clearly visible label bearing the radiation symbol prescribed in 4.27 and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label shall also provide information, such as the radionuclides present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials, and mass enrichment, to permit individuals handling or using the containers, or working in the vicinity of the containers, to take precautions to avoid or minimize exposures.

869 870 871	4.30.2 Each licensee or registrant shall, prior to removal or disposal of empty uncontaminated containers to unrestricted areas, remove or deface the radioactive material label or otherwise clearly indicate that the container no longer contains radioactive materials.
872 873	4.30.3 Each registrant shall ensure that each radiation machine is labeled in a conspicuous manner, which cautions individuals that radiation is produced when it is energized.
874	4.31 Exemptions to Labeling Requirements.
875	A licensee or registrant is not required to label:
876 877	4.31.1 Containers holding licensed or registered material in quantities less than the quantities listed in Appendix 4C; or
878 879	4.31.2 Containers holding licensed or registered material in concentrations less than those specified in Table 4B3 of Appendix 4B; or
880 881	4.31.3 Containers attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the limits established by Part 4; or
882 883	4.31.4 Containers when they are in transport and packaged and labeled in accordance with the regulations of the U.S. Department of Transportation ³⁴ or
884 885 886	34 Labeling of packages containing radioactive materials is required by the U.S. Department of Transportation if the amount and type of radioactive material exceeds the limits for an excepted quantity or article as defined and limited by U.S. Department of Transportation regulations 49 CFR 173.403(m) and (w) and 173.421-424, October 1, 2003.
887 888 889 890 891	4.31.5 Containers that are accessible only to individuals authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to these individuals by a readily available written record. Examples of containers of this type are containers in locations such as water-filled canals, storage vaults, or hot cells. The record shall be retained as long as the containers are in use for the purpose indicated on the record; or
892	4.31.6 Installed manufacturing or process equipment, such as piping and tanks.
893	4.32 Procedures for Receiving and Opening Packages.
894 895 896	4.32.1 Each licensee or registrant who expects to receive a package containing quantities of radioactive material in excess of a Type A quantity, as defined in 17.2 and Appendix 17A of Part 17 of these regulations, shall make arrangements to receive:
897	4.32.1.1 The package when the carrier offers it for delivery; or
898 899	4.32.1.2 The notification of the arrival of the package at the carrier's terminal and to take possession of the package expeditiously.
900	4.32.2 Each licensee or registrant shall:
901 902 903	4.32.2.1 Monitor the external surfaces of a labeled ⁴⁵ package for radioactive contamination unless the package contains only radioactive material in the form of gas or in special form as defined in 1.24 of these regulations; and

- Comment [JJ21]: Reference correction.
- 45 Labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in U.S. Department of Transportation regulations 49
 67 CFR 172.403 and 172.436-440, October 1, 2003.

906 907 908	4.32.2.2 Monitor the external surfaces of a labeled ⁵⁶ package for radiation levels unless the package contains quantities of radioactive material that are less than or equal to the Type A quantity, as defined in 17.2 and Appendix 17A to Part 17 of these regulations; and	
909 910	56 Labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in U.S. Department of Transportation regulations 49 CFR 172.403 and 172.436-440, October 1, 2003.	
911 912 913	4.32.2.3 Monitor all packages known to contain radioactive material for radioactive contamination and radiation levels if there is evidence of degradation of package integrity, such as packages that are crushed, wet, or damaged.	
914 915 916 917 918	4.32.3 The licensee or registrant shall perform the monitoring required by 4.32.2 as soon as practical after receipt of the package, but not later than 3 hours after the package is received at the licensee's or registrant's facility if it is received during the licensee's or registrant's normal working hours, or not later than 3 hours from the beginning of the next working day if it is received after working hours.	
919 920	4.32.4 The licensee or registrant shall immediately notify the final delivery carrier and the Department by telephone, when:	
921 922	4.32.4.1 Removable radioactive surface contamination exceeds the limits of 17.15.8 of these regulations; or	
923	4.32.4.2 External radiation levels exceed the limits of 17.15.9 and 17.15.10 of these regulations.	
924	4.32.5 Each licensee or registrant shall:	
925 926	4.32.5.1 Establish, maintain, and retain written procedures for safely opening packages in which radioactive material is received; and	
927 928	4.32.5.2 Ensure that the procedures are followed and that due consideration is given to special instructions for the type of package being opened.	
929 930 931 932	4.32.6 Licensees or registrants transferring special form sources in vehicles owned or operated by the licensee or registrant to and from a work site are exempt from the contamination monitoring requirements of 4.32.2, but are not exempt from the monitoring requirement in 4.32.2 for measuring radiation levels that ensures that the source is still properly lodged in its shield.	
933	WASTE DISPOSAL	
934	4.33 General Requirements.	
935	4.33.1 A licensee or registrant shall dispose of licensed or registered material only:	
936 937	4.33.1.1 By transfer to an authorized recipient as provided in 4.38 or in Parts 3, 14, or 18 of these regulations, or to the U.S. Department of Energy; or	
938	4.33.1.2 By decay in storage; or	
939	4.33.1.3 By release in effluents within the limits in 4.14; or	Comment [JJ22]: Additional references added for consistency with similar references/section in 10 CFR 20.2001(a)(4).
940	4.33.1.4 As authorized pursuant to 4.34, 4.35, 4.36, 4.37 or 4.39,27.	The additional references provide additional clarity
941 942	4.33.2 A person shall be specifically licensed or registered to receive waste containing licensed or registered material from other persons for:	on options for disposal of radioactive material. NRC Letter dated 10/13/11 (Item 3). RATS 2007-3 NRC Compatibility = C

- 943 4.33.2.1 Treatment prior to disposal; or
- 944 4.33.2.2 Treatment or disposal by incineration; or
- 945 4.33.2.3 Decay in storage; or
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 947
 4.33.2.4 Disposal at a land disposal facility pursuant to Part 14 of these regulations or as authorized under Parts 3 or 18 of these regulations; or
- 948 4.33.2.5 Storage until transferred to a storage or disposal facility authorized to receive the waste.

949 4.34 Method for Obtaining Approval of Proposed Disposal Procedures.

- A licensee or registrant or applicant for a license or registration may apply to the Department for
 approval of proposed procedures, not otherwise authorized in these regulations, to dispose of
 licensed or registered material generated in the licensee's or registrant's operations. Each
 application shall include:
- 9544.34.1 A description of the waste containing licensed or registered material to be disposed of, including955the physical and chemical properties that have an impact on risk evaluation, and the proposed956manner and conditions of waste disposal; and
- 957 4.34.2 An analysis and evaluation of pertinent information on the nature of the environment; and
- 958 4.34.3 The nature and location of other potentially affected facilities; and
- 9594.34.4 Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits
in Part 4.

961 4.35 Disposal by Release into Sanitary Sewerage.

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- 4.35.1 A licensee or registrant may discharge licensed or registered material into sanitary sewerage if
 each of the following conditions is satisfied:
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 4.35.1.1 The material is "readily soluble," or is "readily dispersible biological material," in water;
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 and
- 9664.35.1.2 The quantity of licensed or registered radioactive material that the licensee or registrant967releases into the sewer in 1 month divided by the average monthly volume of water968released into the sewer by the licensee or registrant does not exceed the concentration969listed in Table 4B3 of Appendix 4B; and
- 970 4.35.1.3 If more than one radionuclide is released, the following conditions must also be 971 satisfied:
 - (1) The licensee or registrant shall determine the fraction of the limit in Table 4B3 of Appendix 4B represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee or registrant into the sewer by the concentration of that radionuclide listed in Table 4B3 of Appendix 4B; and
- 977 (2) The sum of the fractions for each radionuclide required by 4.35.1.3.1 does not 978 exceed unity; and

979 980 981 982	4.35.1.4 The total quantity of licensed or registered radioactive material that the licensee or registrant releases into the sanitary sewerage 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.
983 984	4.35.2 Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to the limitations contained in 4.35.1.
985	4.36 Treatment or Disposal by Incineration.
986 987 988	4.36.1 A licensee or registrant may treat or dispose of licensed or registered material by incineration only in the amounts and forms specified in 4.37 or as specifically approved by the Department pursuant to 4.34.
989	4.37 Disposal of Specific Wastes.
990 991	4.37.1 A licensee or registrant may dispose of the following licensed or registered material as if it were not radioactive:
992 993	4.37.1.1 1.85 kBq (0.05 μCi), or less, of hydrogen-3 or carbon-14 per gr am of medium used for liquid scintillation counting; and
994 995	4.37.1.2 1.85 kBq (0.05 μCi), or less, of hydrogen-3 or carbon-14 per gram of animal tissue, averaged over the weight of the entire animal.
996 997	4.37.2 A licensee or registrant shall not dispose of tissue pursuant to 4.37.1.2 in a manner that would permit its use either as food for humans or as animal feed.
998	4.37.3 The licensee or registrant shall maintain records in accordance with 4.48.
999	4.38 Transfer for Disposal and Manifests.
1000 1001 1002 1003 1004 1005	4.38.1 The requirements of 4.38 and Appendix 4D are designed to control transfers of low-level radioactive waste by any waste generator, waste collector, or waste processor licensee, as defined in this part, who ships low-level waste either directly, or indirectly through a waste collector or waste processor, to a licensed low-level radioactive waste disposal facility, establish a manifest tracking system, and supplement existing requirements concerning transfers and recordkeeping for those wastes.
1006 1007 1008 1009	4.38.2 Any licensee shipping radioactive waste intended for ultimate disposal at a licensed land disposal facility shall document the information required on the uniform low-level radioactive waste manifest and transfer this recorded manifest information to the intended consignee in accordance with Appendix 4D.
$\begin{array}{c} 1010\\ 1011 \end{array}$	4.38.3 Each shipment manifest shall include a certification by the waste generator as specified in Section II of Appendix 4D.
1012 1013 1014	4.38.4 Each person involved in the transfer of waste for disposal or in the disposal of waste, including the waste generator, waste collector, waste processor, and disposal facility operator, shall comply with the requirements specified in Section III of Appendix 4D.
1015 1016 1017	4.38.5 Any licensee shipping byproduct material as defined in paragraphs (3) and (4) of the definition of <i>Byproduct material</i> set forth in 1.2. intended for ultimate disposal at a land disposal facility licensed under 10 CFR Part 61, must document the information required

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1018	on the NRC's Uniform Low-Level Radioactive Waste Manifest and transfer this recorded	
1019	manifest information to the intended consignee in accordance with Appendix 4D	Comment [JJ23]: This is a new recordkeeping
1020		20.2006(e). The provision was added to 10 CFR Part
1020	4.39 Additional Requirements	20 in 2007 after the last revision to Part 4. This is a
1021	4.39.1 Compliance with Environmental and Health Protection Regulations.	recordkeeping requirement and applies only when a licensee disposes of certain materials at a facility licensed by NRC under 10 CFR Part 61.
1022	4.39.1.1 Nothing in 4.33, 4.34, 4.35, 4.37, 4.38 or 4.39.28 relieves the licensee or registrant from 1	[SEE 20.2006(e); http://www.nrc.gov/reading-
1023	complying with other applicable Federal, State and local regulations governing any other	rm/doc-collections/cfr/part020/part020-2006.html]
1024	toxic or hazardous properties of materials that may be disposed of pursuant to 4.33, 4.34,	NPC Latters 10/12/2011 (Item 4): 6/28/12
1025	4.35, 4.37 , or 4.38, or 4.39.2.	RATS = $2007-3$
1026	4 20 0 Dispaced of Contain Duranduct Material	Compatibility = B
1020	4.39.2 Disposal of Certain Byproduct Material	has not been revised since NRC added provision.]
1027	4.39.2.1 Licensed material as defined in paragraphs (3) and (4) of the definition of	Comment [JJ24]: EDITORIAL NOTE: Due to
1028	Byproduct material set forth in Part 1, Section 1.2 may be disposed of in	numbering differences between the CFR and
1029	accordance with Part 14 or equivalent regulations of NRC or an Agreement State,	Colorado regulations, this section required minor retitling modification and renumbering to avoid
1030	even though it is not defined as low-level radioactive waste. Therefore, any	a complete revision/renumbering of Part 4.
1031	licensed material being disposed of at a facility, or transferred for ultimate disposal	
1032	at a facility licensed under Part 14, or equivalent regulations of NRC or Agreement State must meet the requirements of 4.38	Formatted: Indent: Left: 0.5", Hanging: 0.5"
1055	otate, must meet the requirements of p.so.	Comment [JJ25]: These are new provisions
1034	4.39.2.2 A licensee may dispose of byproduct material, as defined in paragraphs (3) and (4)	added to be consistent with 10 CFR 20.2008. The provision was added to 10 CFR Part 20 in 2007
1035	of the definition of <i>Byproduct material</i> set forth in Part 1, Section 1.2, at a disposal	following the last revision to Part 4.
1036	facility authorized to dispose of such material in accordance with any Federal or	This provision allows for contain motorials
1037	State solid or hazardous waste law, including the Solid Waste Disposal Act, as	specifically the material defined in paragraphs (3)
1038	authorized under the Energy Policy Act of 2005.	and (4) of the definition of byproduct materials
1039	RECORDS	radioactive waste even though these materials are not
1007		defined as low level radioactive waste. [The
1040	4.40 General Provisions.	Radium sources, radioactive materials produced by
		an accelerator, and discrete sources of NORM - refer
1041	4.40.1 Each licensee or registrant shall use the SI units becquerel, gray, sievert and coulomb per	for the byproduct material definition of Part 1 for further details.]
1042	kilogram, or the special units curie, rad, rem and roentgen, including multiples and subdivisions,	
1045	and shall cleany indicate the units of all quantities on records required by Part 4.	NRC Letter 10/13/2011 (Item 5) Compatibility = C
1044	4.40.2 The licensee or registrant shall make a clear distinction among the quantities entered on the	Formatted: Indent: Hanging: 0.5"
1045	records required by Part 4 (e.g., total effective dose equivalent, total organ dose equivalent,	Comment [1126]: This provision added for
1046	shallow dose equivalent, lens dose equivalent, deep dose equivalent, committed effective dose	consistency with 10 CFR 20.2008.
1047	equivalent).	
1048	4.40.3 The licensee or registrant shall be consistent in their use of SI or special units. The licensee or	Formatted: Not Highlight
1049	registrant shall not change the units used on records required by Part 4 except at the beginning of	Formatted: Indent: Left: 0.5", Hanging: 0.5"
1050	the calendar year or with Department approval.	Formatted: Font: Italic
1051	4.41 Records of Radiation Protection Programs	Formatted: Not Highlight
1051	4.41 Records of Radiation Protection Programs.	Formatted: Not Highlight
1052	4.41.1 Each licensee or registrant shall maintain records of the radiation protection program, including:	Formatted: Not Strikethrough, Not Highlight
1052	4.44.4.4. The provisions of the program and	Formatted: Not Highlight
1033	4.41.1.1 The provisions of the program; and	Formatted: Not Strikethrough, Not Highlight
1054	4.41.1.2 Audits and other reviews of program content and implementation.	Formatted: Not Highlight
		Formatted: Not Highlight

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1055 1056 1057	4.41.2 The licensee or registrant shall retain the records required by 4.41.1.1 until the Department terminates each pertinent license or registration requiring the record. The licensee or registrant shall retain the records required by 4.41.1.2 for 3 years after the record is made.
1058	4.42 Records of Surveys.
1059 1060 1061	4.42.1 Each licensee or registrant shall maintain records showing the results of surveys and calibrations required by 4.17 and 4.32.2. The licensee or registrant shall retain these records for 3 years after the record is made.
1062 1063	4.42.2 The licensee or registrant shall retain each of the following records until the Department terminates each pertinent license or registration requiring the record:
1064 1065 1066	4.42.2.1 Records of the results of surveys to determine the dose from external sources of radiation and used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents; and
1067 1068	4.42.2.2 Records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose; and
1069 1070	4.42.2.3 Records showing the results of air sampling, surveys, and bioassays required pursuant to 4.24.1.3(1) and 4.24.1.3(2); and
1071 1072	4.42.2.4 Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.
1073 1074 1075	4.42.3 Upon termination of the license or registration, the licensee or registrant shall permanently store records on Department Form R-16 or equivalent, or shall make provision with the Department for transfer to the Department.
1076	4.43 Records of Tests for Leakage or Contamination of Sealed Sources.
1077 1078 1079	Records of tests for leakage or contamination of sealed sources required by 4.16 shall be kept in units of becquerel (or microcurie) and maintained for inspection by the Department for 5 years after the records are made.
1080	4.44 Records of Prior Occupational Dose.
1081 1082 1083 1084 1085	4.44.1 The licensee or registrant shall retain the records of prior occupational dose and exposure history as specified in 4.10 on Department Form R-16 or equivalent until the Department terminates each pertinent license or registration requiring this record. The licensee or registrant shall retain records used in preparing Department Form R-16 or equivalent for 3 years after the record is made.
1086 1087 1088	4.44.2 Upon termination of the license or registration, the licensee or registrant shall permanently store records on Department Form R-16 or equivalent, or shall make provision with the Department for transfer to the Department.
1089	4.45 Records of Planned Special Exposures.

- 1090 4.45.1 For each use of the provisions of 4.11 for planned special exposures, the licensee or registrant shall maintain records that describe:
- 1092 4.45.1.1 The exceptional circumstances requiring the use of a planned special exposure; and

1093 1094	4.45.1.2 The name of the management official who authorized the planned special exposure and a copy of the signed authorization; and
1095	4.45.1.3 What actions were necessary; and
1096	4.45.1.4 Why the actions were necessary; and
1097	4.45.1.5 What precautions were taken to assure that doses were maintained ALARA; and
1098	4.45.1.6 What individual and collective doses were expected to result; and
1099	4.45.1.7 The doses actually received in the planned special exposure.
$\begin{array}{c} 1100 \\ 1101 \end{array}$	4.45.2 The licensee or registrant shall retain the records until the Department terminates each pertinent license or registration requiring these records.
1102 1103 1104	4.45.3 Upon termination of the license or registration, the licensee or registrant shall permanently store records on Department Form R-16 or equivalent, or shall make provision with the Department for transfer to the Department.
1105	4.46 Records of Individual Monitoring Results.
1106 1107 1108 1109 1110	4.46.1 Recordkeeping Requirement. Each licensee or registrant shall maintain records of doses received by all individuals for whom monitoring was required pursuant to 4.18, 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:
1111 1112	4.46.1.1 The deep dose equivalent to the whole body, lens dose equivalent, shallow dose equivalent to the skin, and shallow dose equivalent to the extremities;
1113	4.46.1.2 The estimated intake of radionuclides (see 4.7);
1114	4.46.1.3 The committed effective dose equivalent assigned to the intake of radionuclides;
1115 1116	4.46.1.4 The specific information used to assess and calculate the committed effective dose equivalent pursuant to 4.9.1 and 4.9.3, and when required by 4.18;
1117	4.46.1.5 The total effective dose equivalent when required by 4.7; and
1118 1119	4.46.1.6 The total of the deep dose equivalent and the committed dose to the organ receiving the highest total dose.
1120	4.46.2 Recordkeeping Frequency.
1121 1122	The licensee or registrant shall make entries of the records specified in 4.46.1 at intervals not to exceed 1 year.
1123	4.46.3 Recordkeeping Format.

1124The licensee or registrant shall maintain the records specified in 4.46.1 on Department Form R-112517, Occupational Exposure Record for a Monitoring Period, in accordance with the instructions for1126Department Form R-17, or in clear and legible records containing all the information required by1127Department Form R-17.

1128 1129 1130 1131	4.46.4 The licensee or registrant shall maintain the records of dose to an embryo/fetus with the records of dose to the declared pregnant woman. The declaration of pregnancy, including the estimated date of conception, shall also be kept on file, but may be maintained separately from the dose records.
1132 1133	4.46.5 The licensee or registrant shall retain each required form or record until the Department terminates each pertinent license or registration requiring the record.
1134 1135 1136	4.46.6 Upon termination of the license or registration, the licensee or registrant shall permanently store records on Department Form R-16 or equivalent, or shall make provision with the Department for transfer to the Department.
1137	4.47 Records of Dose to Individual Members of the Public.
1138 1139	4.47.1 Each licensee or registrant shall maintain records sufficient to demonstrate compliance with the dose limit for individual members of the public. See 4.14.
$\begin{array}{c} 1140\\ 1141 \end{array}$	4.47.2 The licensee or registrant shall retain the records required by 4.47.1 until the Department terminates each pertinent license or registration requiring the record.
1142	4.48 Records of Waste Disposal.
1143 1144 1145	4.48.1 Each licensee or registrant shall maintain records of the disposal of licensed or registered materials made pursuant to 4.34, 4.35, 4.36, 4.37, Part 14 of these regulations, and disposal by burial in soil, including burials authorized before December 30, 1985.
1146 1147	4.48.2 The licensee or registrant shall retain the records required by 4.48.1 in accordance with 3.15.4 until the Department terminates each pertinent license or registration requiring the record.
1148	4.49 Records of Testing Entry Control Devices for Very High Radiation Areas.
1149 1150 1151	4.49.1 Each licensee or registrant shall maintain records of tests made pursuant to 4.21.2.9 on entry control devices for very high radiation areas. These records must include the date, time, and results of each such test of function.
1152 1153	4.49.2 The licensee or registrant shall retain the records required by 4.49.1 for 3 years after the record is made.
1154	4.50 Form of Records.
1155 1156	Each record required by Part 4 shall be legible throughout the specified retention period. The record shall be the original or a reproduced copy or a microform, provided that the copy or

- 1150nector shall be the original of a reproduced copy of a microform, provided that the copy of1157microform is authenticated by authorized personnel and that the microform is capable of1158producing a clear copy throughout the required retention period or the record may also be stored1159in Department-approved electronic media with the capability for producing legible, accurate, and1160complete records during the required retention period. Records, such as letters, drawings, and1161specifications, shall include all pertinent information, such as stamps, initials, and signatures. The
- 1162 licensee shall maintain adequate safeguards against tampering with and loss of records.
- 1163 REPORTS

1164 **4.51** Reports of Stolen, Lost, or Missing Licensed or Registered Sources of Radiation.

1165 4.51.1 Telephone Reports.

1166	Each licensee or registrant shall report to the Department by telephone as follows:
1167 1168 1169 1170 1171	4.51.1.1 Immediately after its occurrence becomes known to the licensee or registrant, stolen, lost, or missing licensed or registered radioactive material in an aggregate quantity equal to or greater than 1,000 times the quantity specified in Appendix 4C under such circumstances that it appears to the licensee or registrant that an exposure could result to individuals in unrestricted areas; or
1172 1173 1174	4.51.1.2 Within 30 days after its occurrence becomes known to the licensee or registrant, lost, stolen, or missing licensed or registered radioactive material in an aggregate quantity greater than 10 times the quantity specified in Appendix 4C that is still missing.
1175 1176	4.51.1.3 Immediately after its occurrence becomes known to the registrant, a stolen, lost, or missing radiation machine.
1177	4.51.2 Written Reports.
1178 1179 1180	Each licensee or registrant required to make a report pursuant to 4.51.1 shall, within 30 days after making the telephone report, make a written report to the Department setting forth the following information:
1181 1182 1183 1184	4.51.2.1 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;
1185	4.51.2.2 A description of the circumstances under which the loss or theft occurred; and
1186 1187	4.51.2.3 A statement of disposition, or probable disposition, of the licensed or registered source of radiation involved; and
1188 1189 1190	4.51.2.4 Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas; and
1191	4.51.2.5 Actions that have been taken, or will be taken, to recover the source of radiation; and
1192 1193	4.51.2.6 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.
1194 1195 1196	4.51.3 Subsequent to filing the written report, the licensee or registrant shall also report additional substantive information on the loss or theft within 30 days after the licensee or registrant learns of such information.
1197 1198 1199	4.51.4 The licensee or registrant shall prepare any report filed with the Department pursuant to 4.51 so that names of individuals who may have received exposure to radiation are stated in a separate and detachable portion of the report.
1200	4.52 Notification of Incidents.
1201	4.52.1 Immediate Notification.
1202 1203	Notwithstanding other requirements for notification, each licensee or registrant shall notify the Department as soon as possible but not later than 4 hours after the discovery of an event:

Comment [JJ27]: Grammatical correction – comma added.

1204	4.52.1.1 Involving a source of radiation possessed by the licensee or registrant that may have
1205	caused or threatens to cause any of the following conditions:
1206	(1) An individual to receive:
1207	(a) A total effective dose equivalent of 0.25 Sv (25 rem) or more; or
1208	(b) A lens dose equivalent of 0.75 Sv (75 rem) or more; or
1209	(c) A shallow dose equivalent to the skin or extremities or a total organ dose
1210	equivalent of 2.5 Gy (250 rad) or more; or
1211	(2) The release of radioactive material, inside or outside of a restricted area, so that, had
1212	an individual been present for 24 hours, the individual could have received an
1213	intake five times the occupational ALI. This provision does not apply to locations
1214	where personnel are not normally stationed during routine operations, such as
1215	hot cells or process enclosures.
1216	4.52.1.2 That prevents immediate protective actions necessary to avoid exposures to radiation
1217	and/or radioactive materials that could exceed regulatory limits, or releases of licensed
1218	material that could exceed regulatory limits (events may include fires, explosions, toxic
1219	gas releases, etc.).
1220	4.52.2 Twenty-Four Hour Notification.
1221 1222	Each licensee or registrant shall, within 24 hours of discovery of the event, report to the Department:
1223	4.52.2.1 Each event involving loss of control of a licensed or registered source of radiation
1224	possessed by the licensee or registrant that may have caused, or threatens to cause, any
1225	of the following conditions:
1226	(1) An individual to receive, in a period of 24 hours:
1227	(a) A total effective dose equivalent exceeding 0.05 Sv (5 rem); or
1228	(b) A lens dose equivalent exceeding 0.15 Sv (15 rem); or
1229	(c) A shallow dose equivalent to the skin or extremities or a total organ dose
1230	equivalent exceeding 0.5 Sv (50 rem); or
1231	(2) The release of radioactive material, inside or outside of a restricted area, so that, had
1232	an individual been present for 24 hours, the individual could have received an
1233	intake in excess of one occupational ALI. This provision does not apply to
1234	locations where personnel are not normally stationed during routine operations,
1235	such as hot-cells or process enclosures.
1236	4.52.2.2 An unplanned contamination event that:
1237	 Requires access to the contaminated area, by workers or the public, to be restricted
1238	for more than 24 hours by imposing additional radiological controls or by
1239	prohibiting entry into the area;
1240	(2) Involves a quantity of material greater than five times the lowest annual limit on
1241	intake specified in Appendix 4B for the material; and
1242	(3) Has access to the area restricted for a reason other than to allow isotopes with a half-
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1243	life of less than 24 hours to decay prior to decontamination.
1244	4.52.2.3 An event in which equipment is disabled or fails to function as designed when:
1245	(1) The equipment is required by regulation or license condition to prevent releases
1246	exceeding regulatory limits, to prevent exposures to radiation and/or radioactive
1247	materials exceeding regulatory limits, or to mitigate the consequences of an
1248	accident; and
1249	(2) The equipment is required to be available and operable when it is disabled or fails to
1250	function during the event; and
1251	(3) No redundant equipment is available and operable to perform the required safety
1252	function.
1253 1254	4.52.2.4 An event that requires unplanned medical treatment at a medical facility of an individual whose body or clothing is contaminated with spreadable radioactive material.
1255	4.52.2.5 An unplanned fire or explosion damaging any licensed material or any device, container,
1256	or equipment containing licensed material when:
1257	(1) The quantity of material involved is greater than five times the lowest annual limit on
1258	intake specified in Appendix 4B for the material; and
1259	(2) The damage affects the integrity of the licensed material or its container.
1260	4.53 Preparation and Submission of Reports.
1261 1262	4.53.1 Reports made by licensees or registrants in response to the requirements of 4.52, must be made as follows:
1263	4.53.1.1 Licensees or registrants shall make the reports required by 4.52.1 and 4.52.2 to the
1264	Department by telephone. To the extent that the information is available at the time of
1265	notification, the information provided in these reports must include:
1266	(1) The caller's name and call back telephone number;
1267	(2) A description of the event including date and time;
1268	(3) The exact location of the event;
1269	(4) The isotopes, quantities, and chemical and physical form of the licensed material
1270	involved; and
1271	(5) Any personnel radiation exposure data available.
1272	4.53.1.2 Each licensee or registrant who makes a report required by 4.52.1 or 4.52.2 shall submit
1273	a written follow-up report to the Department pursuant to 4.53.3 within 30 days of the initial
1274	report. Written reports prepared pursuant to other regulations may be submitted to fulfill
1275	this requirement if the reports contain all of the necessary information and the appropriate
1276	distribution is made.

1277 1278 1279	4.53.1.3 The provisions of 4.52 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 4.54.
1280 1281	4.53.2 Reports of Exposures, Radiation Levels, and Concentrations of Radioactive Material Exceeding the Constraints or Limits.
1282 1283	In addition to the notification required by 4.52, each licensee or registrant shall submit a written report to the Department within 30 days after learning of any of the following occurrences:
1284	4.53.2.1 Incidents for which notification is required by 4.52; or
1285	4.53.2.2 Doses in excess of any of the following:
1286	(1) The occupational dose limits for adults in 4.6; or
1287	(2) The occupational dose limits for a minor in 4.12; or
1288	(3) The limits for an embryo/fetus of a declared pregnant woman in 4.13; or
1289	(4) The limits for an individual member of the public in 4.14; or
1290	(5) Any applicable limit in the license or registration; or
1291	(6) The ALARA constraints for air emissions established under 4.5.4.
1292	4.53.2.3 Levels of radiation or concentrations of radioactive material in:
1293	(1) A restricted area in excess of applicable limits in the license or registration; or
1294 1295 1296	(2) An unrestricted area in excess of 10 times the applicable limit set forth in Part 4 or in the license or registration, whether or not involving exposure of any individual in excess of the limits in 4.14; or
1297 1298 1299 1300	4.53.2.4 For licensees subject to the provisions of U.S. Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190, July 1, 2004, levels of radiation or releases of radioactive material in excess of those standards, or of license conditions related to those standards.
1301	4.53.3 Contents of Written Reports.
1302	4.53.3.1 Each report required by 4.53.1.2 or 4.53.2 shall include the following, as appropriate:
1303 1304	 A description of the event, including the possible cause and the manufacturer and model number (if applicable) of any equipment that failed or malfunctioned;
1305	(2) The exact location of the event;
1306 1307	(3) The isotopes, quantities, and chemical and physical form of the licensed material involved;
1308	(4) Date and time of the event;
1309	(5) The results of any evaluations or assessments, including:

1310	(a) Estimates of each individual's dose;	
1311	(b) The levels of radiation and concentrations of radioactive material involved;	
1312	(c) The cause of the elevated exposures, dose rates, or concentrations; and	
1313 1314 1315 1316	(d) Corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, ALARA constraints, generally applicable environmental standards, and associated license or registration conditions.	
1317 1318 1319 1320 1321 1322	4.53.3.2 Each report filed pursuant to 4.53 shall include for each occupationally overexposed individual exposed: the name, Social Security account number, and date of birth. With respect to the limit for the embryo/fetus in 4.13, the identifiers should be those of the declared pregnant woman. The report shall be prepared so that this information is stated in a separate and detachable portion of the report and must be clearly labeled "Privacy Act Information: Not for Public Disclosure".	
1323	4.54 Reports of Planned Special Exposures.	c
1324 1325 1326 1327	4.54.1 The licensee or registrant shall submit a written report to the Department within 30 days following any planned special exposure conducted in accordance with 4.11, informing the Department that a planned special exposure was conducted and indicating the date the planned special exposure occurred and the information required by 4.45.	
1328	4.55 Reserved Reports of Transactions Involving Nationally Tracked Sources	1
1329 1330 1331	4.55.1 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 4.55.1.1 through 4.55.1.5 for each type of transaction.	I f T
1332 1333 1334	4.55.1.1 Each licensee who manufactures a nationally tracked source shall complete and submit a National Source Tracking Report. The report must include the following information:	r t f
1335	(1) The name, address, and license number of the reporting licensee;	i I
1336	(2) The name of the individual preparing the report;	1
1337	(3) The manufacturer, model, and serial number of the source;	I C
1338	(4) The radioactive material in the source;	1
1339	(5) The initial source strength in becquerels (curies) at the time of manufacture;	i
1340	and	t
1341	(6) The manufacture date of the source	I
1342		
1343		L ²

Comment [JJ28]: Added subsection numbering consistent with format of regulations.

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Comment [JJ29]: Section 4.55 is added for consistency with 10 CFR Part 20.2207.

This section <u>does not</u> contain new requirements for regulated entities, but will <u>replace</u> the requirements currently contained in legally binding license conditions contained within certain radioactive materials licenses. The requirements of this section have been in effect and have been enforced through license conditions since ~2008 and affect < 10 % of licenses.

Following the events of September 11, the NRC formally initiated efforts to enhance security related requirements associated with certain higher level radioactive sources. One of these enhanced security efforts is known as the National Source Tracking System (NSTS). The NRC initiated these additional requirements through legal Orders to licensees and through regulatory changes. Due to the short time rame for implementation required by the NRC, Agreement States such as Colorado chose to implement the additional security related requirements through legally binding license onditions. Colorado has been enforcing the requirements through that mechanism for 4+ years. These requirements apply only to radioactive materials licensees having certain higher risk quantities of material (refer to the definition for ationally tracked source in Part 1, and Appendix 4G).

Section 4.55 will "codify" the requirements already in effect relating to the NSTS. Once revisions to Part 4 become effective, the Department will modify certain license conditions to reference this section of the regulations.

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1344	4.55.1.2 Each licensee that transfers a nationally tracked source to another person shall	
1345	complete and submit a National Source Tracking Transaction Report. The report	
1346	must include the following information:	
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1347	(1) The name, address, and license number of the reporting licensee;	12 pt, After: 0 pt
1348	(2) The name of the individual preparing the report;	
1349	(3) The name and license number of the recipient facility and the shipping address;	
1350	(4) The manufacturer, model, and serial number of the source or, if not available,	
1351	other information to uniquely identify the source;	
1050		
1352	(5) The radioactive material in the source;	
1252		
1555	(b) The initial of current source strength in becquerels (curres);	
1254	(7) The date for which the course strength is reported.	
1334	(7) The date for which the source strength is reported,	
1355	(8) The shinning date:	
1555	(b) The shipping date,	
1356	(9) The estimated arrival date:	
1000	(),,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
1357	and	
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1358	(10) For nationally tracked sources transferred as waste under a Uniform Low-	
1359	Level Radioactive Waste Manifest, the waste manifest number and the	
1360	container identification of the container with the nationally tracked source.	
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1361	4.55.1.3 Each licensee that receives a nationally tracked source shall complete and submit	Formatted: Indent: Left: 0.5", Space Before:
1362	a National Source Tracking Transaction Report. The report must include the following	12 pt, After: 0 pt
1363	information:	
1264	(4) The name address and license number of the repetitor licenses:	
1304	(1) The name, address, and license number of the reporting licensee;	
1365	(2) The name of the individual propering the report:	
1305	(z) the name of the individual preparing the report,	
1366	(3) The name address and license number of the person that provided the source	
1500		
1367	(4) The manufacturer, model, and serial number of the source or, if not available,	
1368	other information to uniquely identify the source:	
1369	(5) The radioactive material in the source;	
1370	(6) The initial or current source strength in becquerels (curies);	
1371	(7) The date for which the source strength is reported;	
1070		
1372	(8) The date of receipt;	
1272	and	
13/3	and	Example Control (Default) Arial 10 at
1374	(0) For material received under a Uniform Low-Level Padioactive Waste Manifest	Formatted: Font: (Default) Ariai, 10 pt
1375	the waste manifest number and the container identification with the nationally	Formatted: Normal, Indent: Left: 1", Space
1376	tracked source.	Delote: 12 pt
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1377	4.55.1.4 Each licensee that disassembles a nationally tracked source shall complete and	Formatted: Title2, Indent: Left: 1", Space Before: 0 pt, After: 0 pt
1378 1379	submit a National Source Tracking Transaction Report. The report must include the following information:	Formatted: English (U.S.)
1380	(1) The name, address, and license number of the reporting licensee;	
1381	(2) The name of the individual preparing the report;	
1382 1383	(3) The manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;	
1384	(4) The radioactive material in the source;	
1385	(5) The initial or current source strength in becquerels (curies);	
1386	(6) The date for which the source strength is reported;	
1387	(7) The disassemble date of the source.	
1388 1389 1390	4.55.1.5 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:	Formatted: Indent: Left: 0.5"
1391	(1) The name, address, and license number of the reporting licensee;	Formatted: Indent: Left: 1", Space Before: 12 pt, After: 0 pt
1392	(2) The name of the individual preparing the report;	
1393	(3) The waste manifest number;	
1394	(4) The container identification with the nationally tracked source.	
1395	(5) The date of disposal;	
1396	and	
1397	(6) The method of disposal.	Formatted: Indent: Left: 1"
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1398 1399	4.55.1.6 The reports discussed in 4.55.1.1 through 4.55.1.5 must be submitted by the close of the next business day after the transaction. A single report may be submitted for	Formatted: Indent: Left: 0.5", Hanging: 0.5", Space Before: 12 pt. After: 0 pt
1400 1401	multiple sources and transactions. The reports must be submitted to the National Source Tracking System by using:	Formatted: Font: (Default) Arial, 10 pt, Not Highlight
1402	(1) The on-line National Source Tracking System;	Formatted: Font: (Default) Arial, 10 pt
1403	(2) Electronically using a computer readable format;	
1404	(3) By facsimile;	
1405 1406	(4) By mail to the address on the National Source Tracking Transaction Report Form (NRC Form 748); or	
1407	(5) By telephone with followup by facsimile or mail.	
1408 1409	4.55.2 Each licensee shall correct any error in previously filed reports or file a new report for any missed transaction within 5 business days of the discovery of the error or missed	

1410 1411 1412 1413 1414 1415	transaction. Such errors r reviews or by physical inv reconcile the inventory of that licensee's data in the conducted during the mou include resolving any disc	nay be detected by a variet ventories required by regula nationally tracked sources National Source Tracking S nth of January in each year crepancies between the Nat	y of methods such as administrative ation. In addition, each licensee shal possessed by the licensee against System. The reconciliation must be . The reconciliation process must ional Source Tracking System and	I
1416 1417	the actual inventory by file 31 of each year, each lice	ing the reports identified by nsee must submit to the Na	/ 4.55.1.1 through 4.55.1.5. By Janua tional Source Tracking System	ry Formatted: Font: (Default) A Highlight
1418	confirmation that the data	in the National Source Tra	cking System is correct.	Formatted: Font: (Default) A
1419	4.56 Reports of Individual Monito	oring.		
1420	4.56.1 This section applies to each	person licensed or registered	by the Department to:	
1421 1422	4.56.1.1 Possess or use so Parts 3 and 5 of the	purces of radiation for purpose ese regulations; or	es of industrial radiography pursuant to	
1423 1424	4.56.1.2 Receive radioactiv regulations; or	ve waste from other persons f	or disposal pursuant to Part 14 of these	9
1425 1426 1427	4.56.1.3 Possess or use at Part 3 or 7 of these the following quanti	any time, for processing or m regulations, radioactive mate ties:	nanufacturing for distribution pursuant t rial in quantities exceeding any one of	0
	Radionuclide	Activity ⁶⁷	Activity ⁶⁷	
	•	Ci	GBq	
	Cesium-137	1	37	
	Cobalt-60	1	37	
	Gold-198	100	3.700	
	Iodine-131	1	37	
	Iridium-192	10	370	
	Krypton-85	1 000	37,000	
	Promethium-147	10	370	
	Technetium- 99m	1 000	37,000	
1/28	Technetium- 99m	1,000	57,000	
1429 1430 1431	67 The Department may require as a license registrants who are licensed or registered to levels.	e condition, or by rule, regulation, or use radionuclides not on this list, in o	order pursuant to 1.9, reports from licensees or quantities sufficient to cause comparable radiatio	n
1432 1433 1434 1435 1436 1437	4.56.2 Each licensee or registrant in Department of the results of individual for whom monitor may include additional data The licensee or registrant sl approved electronic media of	n a category listed in 4.56.1 s f individual monitoring carried ing was required by 4.18 duri for individuals for whom mor hall use Department Form R- containing all the information	hall submit an annual report to the out by the licensee or registrant for ea ng that year. The licensee or registrant itoring was provided but not required. 17 or equivalent or Department- required by Department Form R-17.	ch
1438 1439	4.56.3 The licensee or registrant sh or before April 30 of each ye	all file the report required by ear.	4.56.2, covering the preceding year, or	1
1440	4.57 Notifications and Reports to	Individuals.		
1441 1442	4.57.1 Requirements for notification material are specified in 10.	n and reports to individuals of 4 of these regulations.	exposure to radiation or radioactive	

Arial, 10 pt, Not Arial, 10 pt

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1451 1452	leakage or contamination indicates a sealed source is leaking or contaminated. The report shall include the equipment involved, the test results and the corrective action taken.
1453	ADDITIONAL REQUIREMENTS
1454	4.59 Vacating Premises.
1455 1456 1457 1458 1459	4.59.1 Each specific licensee or registrant shall, no less than 30 days before vacating or relinquishing possession or control of premises which may have been contaminated with radioactive material as a result of the licensee's or registrant's activities, notify the Department in writing of intent to vacate. When deemed necessary by the Department, the licensee shall decontaminate the premises in such a manner as the Department may specify.
1460	4.60 Permissible Levels of Radioactive Material in Uncontrolled Areas.
1461 1462 1463 1464 1465	4.60.1 Plutonium. Contamination of the soil in excess of 2.0 disintegrations per minute (0.03 Bq) of plutonium per gram of dry soil or square centimeter of surface area (0.01 microcurie [370 Bq] per square meter) presents a sufficient hazard to the public health to require the utilization of special techniques of construction upon property so contaminated. Evaluation of proposed control techniques shall be available from the Department upon request.
1466	4.61 Radiological Criteria For License Termination.
1467 1468 1469 1470	4.61.1 The criteria in this section apply to the decommissioning of facilities licensed under Parts 3, 5, 7, 14, 16, and 19 of these regulations. For low-level waste disposal facilities licensed under Part 14, the criteria apply only to the ancillary surface facilities that support radioactive waste disposal activities.
1471 1472 1473 1474 1475	4.61.1.1 The criteria in this section do not apply to uranium and thorium recovery facilities already subject to Appendix 18A of Part 18; uranium solution extraction facilities; sites which have been decommissioned and the license terminated prior to July 1, 1999; or sites which submitted a decommissioning plan prior to July 1, 2000 and received Department approval of that decommissioning plan prior to July 1, 2001.
1476 1477 1478 1479 1480	4.61.1.2 When calculating the TEDE to the average member of the critical group, the licensee shall determine the peak annual TEDE expected within the first 1000 years after decommissioning. In accordance with 1.5.1, the Department may authorize the licensee to exclude dose contributions from the inhalation of radon and its decay products when calculating TEDE.
1481 1482 1483 1484	4.61.1.3 Determination of dose and residual radioactivity levels which are as low as reasonably achievable (ALARA) must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.

4.57.2 When a licensee or registrant is required pursuant to 4.53.2 or 4.54 to report to the Department

4.58.1 The licensee or registrant shall file a report within 5 days with the Department if the test for

and shall comply with the provisions of 10.4.1 of these regulations.

4.58 Reports of Leaking or Contaminated Sealed Sources.

any exposure of an identified occupationally exposed individual or an identified member of

the public, to radiation or radioactive material, the licensee or registrant shall also providenctify

the individual a report on his or her exposure data included in the report to the Department.

Such reportnetice shall be transmitted at a time not later than the transmittal to the Department,

Comment [JJ30]: Language inserted for consistency with 10 CFR 20.2205.

The language clarifies that reports to the Department already required by 4.53.2 or 4.54 (planned special exposures) for an occupationally exposed individual or member of the public must also be provided to the affected individual.

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4.61.2 Radiological Criteria For Unrestricted Use.

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1486	A site will be considered acceptable for license termination under conditions of unrestricted use if	
1487	the residual radioactivity that is distinguishable from background radiation results in a TEDE to an	
1488	average member of the critical group that does not exceed 0.25 mSy per year (25 mrem/y).	
1489	including that from groundwater sources of drinking water, and the residual radioactivity has been	
1490	reduced to levels that are AI APA	
1490	Teduceu to levels that are ALANA.	
1491	4.61.3 Radiological Criteria For Restricted Use.	
1492	A site will be considered acceptable for license termination under restricted conditions if:	
1493	4.61.3.1. The licensee can demonstrate that further reductions in residual radioactivity necessary	
1494	to comply with the provisions of 4.61.2 would result in net public or environmental harm	
1/05	or worp not heing mode because the residual levels of contamination associated with	
1495	or were not being made because the residual reversion containing the associated with	
1490	restricted conditions are ALARA. Determination of the levels which are ALARA must	
1497	take into consideration any detriments, such as traffic accidents, expected to	
1498	potentially result from decontamination and waste disposal;	Comment [JJ31]: The provision of 4.61.3.1 (and
		subsections) are added for consistency with 10 CFR
1499	4.61.3.2 The licensee has made provisions for durable, legally enforceable institutional controls	20.1403(a).
1500	which provide reasonable assurance that the TEDE from residual radioactivity	
1500	distinguishable from bealvaround to the guerrage member of the gridial additionary	This provision adds a requirement that when
1501	distinguishable from background to the average member of the childran group will not	considering whether levels (of residual radioactivity)
1502	exceed 0.25 mSv per year (25 mrem/y). ; and	are ALAKA it must also consider the possible
		decontamination and transporting such residual
1503	4.61.3.3 The licensee has provided sufficient financial assurance to enable an	radioactivity (waste)
1504	independent third party, including a governmental custodian of a site, to assume	nationeli (((aste))
1505	and carry out responsibilities for any pecessary control and maintenance of the	Compatibility=C
1506	site Accentable financial assurance mechanisms are :	
1500		Comment [JJ32]: The provisions of 4.61.3.3
1507		CFR 20 1403. These provisions add specific
1507	(1) Funds placed into an account segregated from the licensee's assets and	requirements and clarity on accentable financial
1508	outside the licensee's administrative control as described in Part 3, Section	assurance mechanisms applicable to licensees who
1509	3.9.5.4(2)(a) ;	are terminating their license but wish to do so under
		restricted use conditions.
1510	(2) In the case of Federal, State, or local Government licensees, a statement of	
1511	intent containing a cost estimate for decommissioning and indicating that funds	[Refer to Federal Register, Vol. 76, No. 117, June
1512	for decommissioning will be obtained when persoarry or	17, 2011 for further background information. FRN
1312	for decommissioning will be obtained when necessary, or	33312]
1512	(2) When a governmental entity is accuming sustady and supership of a site an	Compatibility = C
1515	(3) when a governmental entity is assuming custody and ownership of a site, an	RATS = 2011-1
1514	arrangement that is deemed acceptable by such governmental entity; and	[Due date for state adoption = Dec. 2015]
		Comment [1133]: Added section/sub-section
1515	4.61.3.4 Residual radioactivity at the site has been reduced so that if the institutional controls	formatting
1516	were no longer in effect, there is reasonable assurance that the TEDE from residual	Torrina ang.
1517	radioactivity distinguishable from background to the average member of the critical group	
1518	is ALARA and would not exceed either:	
1010		
1510	(1) 1 mSy per very (100 mrombil) or	
1517		
1500		
1520	(2) 5 mSv per year (500 mrem/y), provided the licensee:	
		Formatted: Indent: Left: 1"
1521	(a) demonstrates that further reductions in residual radioactivity necessary to	
1522	comply with the 1-mSv-per-year (100 mrem/y) value of this paragraph are not	
1523	technically achievable, would be prohibitively expensive, or would result in net	
1524	public or environmental harm	
1027		
1525	4.61.4 Alternate Criteria For License Termination	
1323	4.01.4 Alternate Ontena FUI LICENSE TEIMINATION.	

1526 1527	4.61.4.1 The Department may terminate a license using alternate criteria greater than the dose criterion of 4.61.2 or 4.61.3.2, if:
1528	 The licensee has performed an analysis for possible sources of exposure to radiation
1529	which provides assurance that public health and safety would continue to be
1530	protected, and that it is unlikely the TEDE to an average member of the critical
1531	group from all radiation that is distinguishable from background radiation, other
1532	than medical, would be more than 1 mSv per year (100 mrem/y);
1533	(2) The licensee has employed, to the extent practical, restrictions on site use which
1534	minimize exposures at the site in accordance with the provisions of 4.61.3; and
1535	(3) The licensee has reduced doses to levels which are ALARA.
1536	(4) Has provided sufficient financial assurance in the form of a trust fund to enable
1537	an independent third party, including a governmental custodian of a site, to
1538	assume and carry out responsibilities for any necessary control and
1539	maintenance of the site.

1540 PART 4, APPENDIX 4A: ASSIGNED PROTECTION FACTORS FOR RESPIRATORS

1541	ASSIGNED PROTECTION FACT	ORS FOR RESPIRATORS ^a Operating Mode	Assigned Protection Factors
	I. Air purifying respirators [particulate ^b only] ^c :		
	Filtering facepiece disposable	Negative pressure	(^d)
	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
	Facepiece, full	Continuous flow	1000
	Facepiece, full	Pressure demand	1000
	Helmet/hood	Continuous flow	1000

Comment [JJ34]: Language added for consistency with 10 CFR Part 20.1404(a)(5).

The requirement mandates that certain financial assurance requirements be met where alternate criteria for license termination are used, and that the financial assurance is sufficient to control and maintain the site.

NRC Compatibility = C NRC RATS ID = 2011-1 NRC effective date = 12/2012 [Due date for state adoption = 12/2015]

Continuous flow	25
Continuous flow	(^g)
Demand	^h 100
Pressure demand	ⁱ 10,000
Demand, recirculating	^h 100
Positive pressure	ⁱ 10,000
recirculating	
•	•
Assigned protection	
factor for type and mode	
of operation as listed	
above.	
	Continuous flow Continuous flow Demand Pressure demand Demand, recirculating Positive pressure recirculating Assigned protection factor for type and mode of operation as listed above.

1542

1543 1544 1545 1546 a These assigned protection factors apply only in a respiratory protection program that meets the requirements of this part. 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 such circumstances must also comply with department of labor regulations.

Radioactive contaminants for which the concentration values in Table 4B1, Column 3 of Appendix 4B 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.

1550 1551 1552 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.

1553 1554 c The licensee may apply to the commission for the use of an APF greater than 1 for sorbent cartridges as protection against airborne radioactive gases and vapors (e.g., radioiodine).

1555 1556 1557 1558 1559 1560 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 pre-use user seal check on this type of device. All other respiratory protection program requirements listed in 4.24.1 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.

1561 1562 1563 1564 1565 e Under-chin type only. No distinction is made in this appendix 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.

1566 1567 1568 1569 1570 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

1571 1572 1573 g No National Institute of Occupational Safety and Health (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 (that is, 4.24.1).

1574 1575 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.

1580 1581 1582 1583	PART 4, APPENDIX 4B: ANNUAL LIMITS ON INTAKE (ALI) AND DERIVED AIR CONCENTRATIONS (DAC) OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SANITARY SEWERAGE
1584 1585 1586	ANNUAL LIMITS ON INTAKE (ALI) AND DERIVED AIR CONCENTRATIONS (DAC) OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SANITARY SEWERAGE
1587	Introduction
1588 1589 1590 1591 1592 1593 1594 1595	For each radionuclide, Table 4B1 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 μ m, micron, and for three classes (D, W, Y) of radioactive material, which refer to their retention (approximately d ays, weeks or years) in the pulmonary region of the lung. This classification applies to a range of clearance half times for D if less than 10 days, for W from 10 to 100 days, and for Y greater than 100 days. Table 4B2 provides concentration limits for airborne and liquid effluents released to the general environment. Table 4B3 provides concentration limit for discharges to sanitary severage.
1596	Note:

limits

1597 The values in Table 4B1, Table 4B2, and Table 4B3 are presented in the computer "E" notation. In this 1598 notation a value of 6E-02 represents a value of 6 x 10⁻² or 0.06, 6E+2 represents 6 x 10⁻² or 600, and 6E+0 represents 6×10^{-0} or 6. 1599

1600 Table 4B1 "Occupational Values"

1601 Note that the columns in Table 4B1 of this appendix captioned "Oral Ingestion ALI," "Inhalation ALI," and 1602 "DAC," are applicable to occupational exposure to radioactive material.

1603 The ALIs in this appendix are the annual intakes of given radionuclide by "reference man" which would 1604 result in either (1) a committed effective dose equivalent of 0.05 Sv (5 rem), stochastic ALI, or (2) a 1605 committed dose equivalent of 0.5 Sv (50 rem) to an organ or tissue, non-stochastic ALI. The stochastic 1606 ALIs were derived to result in a risk, due to irradiation of organs and tissues, comparable to the risk 1607 associated with deep dose equivalent to the whole body of 0.05 Sv (5 rem). The derivation includes 1608 multiplying the committed dose equivalent to an organ or tissue by a weighting factor, w T. This weighting 1609 factor is the proportion of the risk of stochastic effects resulting from irradiation of the organ or tissue, T, 1610 to the total risk of stochastic effects when the whole body is irradiated uniformly. The values of w $_{T}$ are

1611 listed under the definition of weighting factor in 4.3. The non-stochastic ALIs were derived to avoid nonstochastic effects, such as prompt damage to tissue or reduction in organ function. 1612

1613 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 1614 1615 disregarded. The following portions of the GI tract - stomach, small intestine, upper large intestine, and 1616 lower large intestine — are to be treated as four separate organs.

1617 Note that the dose equivalents for an extremity, skin and lens of the eye are not considered in computing 1618 the committed effective dose equivalent, but are subject to limits that must be met separately.

1619 When an ALI is defined by the stochastic dose limit, this value alone is given. When an ALI is determined

1620 by the non-stochastic dose limit to an organ, the organ or tissue to which the limit applies is shown, and 1621 the ALI for the stochastic limit is shown in parentheses. Abbreviated organ or tissue designations are

1622 used: Comment [JJ35]: Added "4B" to table number for consistency within Appendix B.

- 1623 LLI wall = lower large intestine wall;
- 1624 St. wall = stomach wall;
- 1625 Blad wall = bladder wall; and
- Bone surf = bone surface.

1627 The use of the ALIs listed first, the more limiting of the stochastic and non-stochastic ALIs, will ensure that 1628 non-stochastic effects are avoided and that the risk of stochastic effects is limited to an acceptably low 1629 value. If, in a particular situation involving a radionuclide for which the non-stochastic ALI is limiting, use 1630 of that non-stochastic ALI is considered unduly conservative, the licensee may use the stochastic ALI to 1631 determine the committed effective dose equivalent. However, the licensee shall also ensure that the 0.5 1632 Sv (50 rem) dose equivalent limit for any organ or tissue is not exceeded by the sum of the external deep 1633 dose equivalent plus the internal committed dose equivalent to that organ, not the effective dose. For the 1634 case where there is no external dose contribution, this would be demonstrated if the sum of the fractions 1635 of the nonstochastic ALIs (ALI ns) that contribute to the committed dose equivalent to the organ receiving 1636 the highest dose does not exceed unity, that is, \sum (intake (in μ Ci) of each radionuclide/ALI ns) \leq 1.0. If there is an external deep dose equivalent contribution of H $_{\rm d}$, then this sum must be less than 1 - (H $_{\rm d}$ 1637 1638 /50), instead of \leq 1.0.

1639 Note that the dose equivalents for an extremity, skin, and lens of the eye are not considered in computing 1640 the committed effective dose equivalent, but are subject to limits that must be met separately.

1641The derived air concentration (DAC) values are derived limits intended to control chronic occupational1642exposures. The relationship between the DAC and the ALI is given by:

1643 DAC = ALI (in μ Ci)/(2000 hours per working year x 60 minutes/hour x 2 x 10⁴ ml per minute) = (ALI/2.4 x 10⁹) μ Ci/ml, where 2 x 10⁴ ml is the volume of air breathed per minute at work by reference man under working conditions of light work.

1646The DAC values relate to one of two modes of exposure: either external submersion or the internal1647committed dose equivalents resulting from inhalation of radioactive materials. DACs based upon1648submersion are for immersion in a semi-infinite cloud of uniform concentration and apply to each1649radionuclide separately.

1650The ALI and DAC values include contributions to exposure by the single radionuclide named and any in-1651growth of decay product radionuclides produced in the body by decay of the parent. However, intakes1652that include both the parent and decay product radionuclides should be treated by the general method1653appropriate for mixtures.

1654The values of ALI and DAC do not apply directly when the individual both ingests and inhales a1655radionuclide, when the individual is exposed to a mixture of radionuclides by either inhalation or ingestion1656or both, or when the individual is exposed to both internal and external irradiation. See 4.7. When an1657individual is exposed to radioactive materials which fall under several of the translocation classifications1658of the same radionuclide, such as, Class D, Class W, or Class Y, the exposure may be evaluated as if it1659were a mixture of different radionuclides.

1660 It should be noted that the classification of a compound as Class D, W, or Y is based on the chemical
1661 form of the compound and does not take into account the radiological half-life of different radionuclides.
1662 For this reason, values are given for Class D, W, and Y compounds, even for very short-lived
1663 radionuclides.

1664 Table 4B2 "Effluent Concentrations"

Comment [JJ36]: Added "4B" to table number for consistency within Appendix B.

1665The columns in Table 4B2 of this appendix captioned "Effluents," "Air" and "Water" are applicable to the1666assessment and control of dose to the public, particularly in the implementation of the provisions of 4.15.1667The concentration values given in Columns 1 and 2 of Table 4B2 are equivalent to the radionuclide1668concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total1669effective dose equivalent of 0.5 mSv (0.05 rem).

1670Consideration of non-stochastic limits has not been included in deriving the air and water effluent1671concentration limits because non-stochastic effects are presumed not to occur at or below the dose levels1672established for individual members of the public. For radionuclides, where the non-stochastic limit was1673governing in deriving the occupational DAC, the stochastic ALI was used in deriving the corresponding1674airborne effluent limit in Table 4B2. For this reason, the DAC and airborne effluent limits are not always1675proportional as they were in Appendix A of Part D of the Eighth Edition of Volume I of the Suggested1676State Regulations for Control of Radiation, April 2004.

1677 The air concentration values listed in Table 4B2, Column 1, were derived by one of two methods. For 1678 those radionuclides for which the stochastic limit is governing, the occupational stochastic inhalation ALI 1679 was divided by 2.4 x 10⁹, relating the inhalation ALI to the DAC, as explained above, and then divided by 1680 a factor of 300. The factor of 300 includes the following components: a factor of 50 to relate the 0.05 Sv 1681 (5 rem) annual occupational dose limit to the 0.1 rem limit for members of the public, a factor of 3 to 1682 adjust for the difference in exposure time and the inhalation rate for a worker and that for members of the 1683 public; and a factor of 2 to adjust the occupational values, derived for adults, so that they are applicable to 1684 other age groups.

1685 For those radionuclides for which submersion, that is external dose, is limiting, the occupational DAC in

1686 Table 4B1, Column 3 was divided by 219. The factor of 219 is composed of a factor of 50, as described 1687 above, and a factor of 4.38 relating occupational exposure for 2,000 hours per year to full-time exposure

1087 above, and a factor of 4.38 relating occupational exposure for 2,000 nours per year to full-time exposure
 1688 (8,760 hours per year). Note that an additional factor of 2 for age considerations is not warranted in the
 1689 submersion case.

1690The water concentrations were derived by taking the most restrictive occupational stochastic oral1691ingestion ALI and dividing by 7.3×10^{-7} . The factor of 7.3×10^{-7} (ml) includes the following components:1692the factors of 50 and 2 described above and a factor of 7.3×10^{-5} (ml) which is the annual water intake of1693reference man.

1694Note 2 of this appendix provides groupings of radionuclides which are applicable to unknown mixtures of1695radionuclides. These groupings, including occupational inhalation ALIs and DACs, air and water effluent1696concentrations and releases to sewer, require demonstrating that the most limiting radionuclides in1697successive classes are absent. The limit for the unknown mixture is defined when the presence of one of1698the listed radionuclides cannot be definitely excluded as being present either from knowledge of the1699radionuclide composition of the source or from actual measurements.

1700 Table 4B3 "Releases to Sewerage"

1701The monthly average concentrations for release to sanitary sewerage are applicable to the provisions in17024.35. The concentration values were derived by taking the most restrictive occupational stochastic oral1703ingestion ALI and dividing by 7.3×10^6 (ml). The factor of 7.3×10^6 (ml) is composed of a factor of 7.3×10^5 (ml), the annual water intake by reference man, and a factor of 10, such that the concentrations, if1705the sewage released by the licensee were the only source of water ingested by a reference man during a1706year, would result in a committed effective dose equivalent of 0.5 rem.

1707 Table 4B1, Table 4B2, and Table 4B3 are found at

 1708
 http://www.cdphe.state.co.us/op/regs/radiationcontrol/10070104app.pdfhttp://www.colorado.gov/cs/Sat

 1709
 ellite/CDPHE-Main/CBON/1251595089423

Comment [JJ37]: Added "4B" to table number for consistency within Appendix B.

Comment [JJ38]: EDITORIAL NOTE: CHANGES TO TABLE 4B1, 4B2, AND 4B3 ARE NECESSARY TO INCORPORATE ALI, DAC, AND SEWER EFFLUENT VALUES FOR NITROGEN-13 AND OXYGEN-15 (NOT CURRENTLY IN THE TABLES) FOR COMPATIBILITY WITH NRC IN PART 20 APPENDIX B.

DUE TO THE COMPLEX FORMAT OF THE ORIGINAL TABLE, THE TABLES ARE MAINTAINED AS A DOCUMENT SEPARATE FROM THE MAIN BODY OF PART 4. THE REFERENCE TO THE CDPHE WEBSITE MAY BE MODIFIED PENDING A FINAL DETERMINATION OF DOCUMENT LOCATION.

RATS = 2007-3 Compatibility = A Item 6, NRC Letter 10/13/2011

1710	LIST OF ELEMENTS Name	Atomic Symbol	Atomic Number
	Actinium	Ac	89
	Aluminum	Al	13
	Americium	Am	95
	Antimony	Sb	51
	Argon	Ar	18
	Arsenic	As	33
	Astatine	At	85
	Barium	Ba	56
	Berkelium	Bk	97
	Beryllium	Be	4
	Bismuth	Bi	83
	Bromine	Br	35
	Cadmium	Cd	48
	Calcium	Ca	20
	Californium	Cf	98
	Carbon	С	6
	Cerium	Ce	58
	Cesium	Cs	55
	Chlorine	Cl	17
	Chromium	Cr	24
	Cobalt	Co	27
	Copper	Cu	29
	Curium	Cm	96
	Dysprosium	Dy	66
	Einsteinium	Es	99
	Erbium	Er	68
	Europium	Eu	63
	Fermium	Fm	100
	Fluorine	F	9
	Francium	Fr	87
	Gadolinium	Gd	64
	Gallium	Ga	31
	Germanium	Ge	32
	Gold	Au	79
	Hafnium	Hf	72
	Holmium	Но	67
	Hydrogen	Н	1
	Indium	In	49
	Iodine	Ι	53
	Iridium	Ir	77
	Iron	Fe	26
	Krypton	Kr	36
	Lanthanum	La	57
	Lead	Pb	82
	Lutetium	Lu	71

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Magnesium	Mg	
Manganese	Mn	
Mendelevium	Md	
Mercury	Hg	
Molybdenum	Mo	
Neodymium	Nd	
Neptunium	Np	
Nickel	Ni	
Niobium	Nb	
Nitrogen	Ν	
Osmium	Os	
Oxygen	0	
Palladium	Pd	
Phosphorus	Р	
Platinum	Pt	
Plutonium	Pu	
Polonium	Ро	
Potassium	К	
Praseodymium	Pr	
Promethium	Pm	
Protactinium	Pa	
Radium	Ra	
Radon	Rn	
Rhenium	Re	
Rhodium	Rh	
Rubidium	Rb	
Ruthenium	Ru	
Samarium	Sm	
Scandium	Sc	
Selenium	Se	
Silicon	Si	
Silver	Ag	
Sodium	Na	
Strontium	Sr	
Sulfur	S	
Tantalum	Та	
Technetium	Tc	
Tellurium	Те	
Terbium	Tb	
Thallium	Tl	
Thorium	Th	
Thulium	Tm	
Tin	Sn	
Titanium	Ti	
Tungsten	W	
Uranium	U	

Comment [JJ39]: Elements Nitrogen and Oxygen were added for consistency with Part 20, Appendix B. [SEE PRIOR COMMENT]

NRC Letter 10/13/11 (Item 6) Compatibility = A RATS = 2007-3 [SSRCR equivalent = None available-Part D not revised since NRC added this provision.]

Vanadium	V	23
Xenon	Xe	54
Ytterbium	Yb	70
Yttrium	Y	39
Zinc	Zn	30
Zirconium	Zr	40

1711

PART 4, APPENDIX 4C: QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING 1712 1713 LABELING

QUANTITIES ¹ OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING

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

1714 1715 1716 Licensed or registered mat'l reg labels C1 1717 1007_1_Part4C1.jpg 1718 Licensed or registered mat'l reg labels C2 1719 1007_1_Part4C2.jpg 1720 Licensed or registered mat'l reg labels C3 1721 1007_1_Part4Č3.jpg 1722 1723 Licensed or registered mat'l req labels C4 1007_1_Part4C4.jpg Licensed or registered mat'l req labels C5 1724 1725 1007_1_Part4C5.jpg 1726 Licensed or registered mat'l reg labels C6 1727 1728 1007_1_Part4C6.jpg Licensed or registered mat'l req labels C7 1729 1007_1_Part4C7.jpg 1730 1731 Licensed or registered mat'l reg labels C8 1007_1_Part4C8.jpg 1732 Licensed or registered mat'l req labels C9 1733 1007_1_Part4C9.jpg 1734 Licensed or registered mat'l reg labels C10 1735 1007_1_Part4C10.jpg Licensed or registered mat'l req labels C11 1736 1737 1007_1_Part4C11.jpg 1738 Licensed or registered mat'l reg labels C12 1739 1007_1_Part4Č12.jpg 1740 Licensed or registered mat'l reg labels C13 1741 1007_1_Part4C13.jpg 1742 Licensed or registered mat'l reg labels C14 1743 1007_1_Part4C14.jpg 1744 Licensed or registered mat'l reg labels C15

1745 1007_1_Part4Č15.jpg

1746 Note: For purposes of 4.28.5, 4.31.1, and 4.51.1, where there is involved a combination of radionuclides 1747 in known amounts, the limit for the combination shall be derived as follows: determine, for each 1748 radionuclide in the combination, the ratio between the quantity present in the combination and the limit

1749 otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all

1750 radionuclides in the combination may not exceed "1" - that is, unity.

751 j The quantities listed above were derived by taking 1/10th of the most restrictive ALI listed in Table 4B1, Columns 1 and 2, of Appendix 4B, rounding to the nearest factor of 10, and constraining the values listed between 37 Bq and 37 MBq (0.001 and 1,000 1753 1754 μCi). Values of 3.7 MBq (100 μCi) have been assigned for radionuCides having a radioactive half-life in excess of E+9 years, except Rhenium, 37 MBq (1,000 µCi), to take into account their low specific activity.

Comment [JJ40]: EDITORIAL NOTE: DURING CONVERSION OF FILE FOR EDITING FROM THE OFFICIAL SECRETARY OF STATE'S (SOS) **OFFICE, THESE TABLES/VALUES** CONVERTED FROM AN ACTUAL IMAGE OF THE TABLE TO A IMAGE FILENAME.

THERE ARE NO PROPOSED CHANGES TO THIS APPENDIX 4C TABLE.

1755 1756	5 PART 4, APPENDIX 4D: REQUIREMENTS FOR TRANSFERS OF LOW-LEVEL RADIOACTIVE 6 WASTE FOR DISPOSAL AT LAND DISPOSAL FACILITIES AND MANIFESTS			
1757 1758	REQUIREMENTS FOR TRANSFERS OF LOW-LEVEL RADIOACTIVE WASTE FOR DISPOSAL AT LAND DISPOSAL FACILITIES AND MANIFESTS			
1759	I. Manifest			
1760 1761 1762 1763 1764 1765 1766 1767 1768 1769 1770	A. A waste generator, collector, or processor who transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste land disposal facility must prepare a manifest reflecting information requested on applicable forms 540, uniform low-level radioactive waste manifest (shipping paper), and 541, Uniform Low-Level Radioactive Waste Manifest (container and waste description), and, if necessary, on an applicable Form 542, Uniform Low-Level Radioactive Waste Manifest (manifest index and regional compact tabulation). Forms 540 and 540a must be completed and must physically accompany the pertinent low-level waste shipment. Upon agreement between the shipper and consignee, Forms 541 and 541a and 542 and 542a may be completed, transmitted, and stored in electronic media with the capability for producing legible, accurate and complete records on the respective forms.			
1771 1772	B. Licensees are not required by this department to comply with manifesting requirements of this part when they ship:			
1773 1774	 Low-level radioactive waste for processing and expect its return (that is, for storage under their license) prior to disposal at a licensed land disposal facility; 			
1775 1776	 Low-level radioactive waste that is being returned to the licensee who is the "waste generator" or "generator" as defined in this appendix; or 			
1777 1778	 Radioactively contaminated material to a "waste processor" that becomes the processor's "residual waste". 			
1779 1780 1781 1782	C. For guidance in completing these forms, refer to the instructions that accompany the forms. Copies of manifests required by this appendix may be legible carbon copies, photocopies, or computer printouts that reproduce the data in the format of the uniform manifest.			
1783	D. As used in this appendix, the following definitions apply:			
1784 1785	"Chelating agent" means amine polycarboxylic acids, hydroxy-carboxylic acids, and polycarboxylic acids.			
1786 1787	"Chemical description" means a description of the principal chemical characteristics of the low-level radioactive waste.			
1788 1789	"Consignee" means the designated receiver of the shipment of low-level radioactive waste.			
1790 1791 1792 1793 1794	"Decontamination facility" means a facility operating under a U.S. Nuclear Regulatory Commission or Agreement State license whose principal purpose is decontamination of equipment or materials to accomplish recycle, reuse, or other waste management objectives, and, for the purposes of this Part, is not considered to be a consignee for low- level radioactive waste shipments.			

1795 1796 1797 1798	"Disposal container" means a container principally used to confine low-level radioactive waste during disposal operations at a land disposal facility (also see "high integrity container"). Note that for some shipments, the disposal container may be the transport package.
1799 1800 1801	"EPA identification number" means the number received by a transporter following application to the administrator of the U.S. Environmental Protection Agency as required by 40 CFR Part 263, July 1, 2004.
1802 1803 1804 1805 1806 1807 1808	Forms 540, 540a, 541, 541a, 542, and 542a are official forms referenced in this appendix. Licensees need not use originals of these forms so long as any substitute forms are equivalent to the original documentation in respect to content, clarity, size, and location of information. Upon agreement between the shipper and consignee, Form 541 (and 541a) and Form 542 (and 542a) may be completed, transmitted and stored in electronic media. The electronic media must have the capability for producing legible, accurate, and complete records in the format of the uniform manifest.
1809 1810 1811 1812	"Generator" means a licensee operating under a Nuclear Regulatory Commission or Agreement State license who (1) is a waste generator as defined in this appendix or (2) is a licensee to whom waste can be attributed (for example, waste generated as a result of decontamination or recycle activities).
1813 1814 1815	"High integrity container" (HIC) means a container commonly designed to meet the applicable Nuclear Regulatory Commission structural stability requirements and to meet U.S. Department of Transportation requirements for a Type A package.
1816	"Land disposal facility" means the same as in Part 14 of these regulations.
1817 1818	"Physical description" means the items called for on Form 541 to describe a low-level radioactive waste.
1819 1820 1821 1822	"Residual waste" means low-level radioactive waste resulting from processing or decontamination activities that cannot be easily separated into distinct batches attributable to specific waste generators. This waste is attributable to the processor or decontamination facility, as applicable.
1823 1824 1825 1826	"Shipper" means the licensed entity (that is, the waste generator, waste collector, or waste processor) who offers low-level radioactive waste for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator.
1827 1828 1829	"Shipping paper" means Form 540 and, if required, Form 540a which includes the information required by the U.S. Department of Transportation in 49 CFR Part 172, October 1, 2003.
1830 1831 1832	"Uniform low-level radioactive waste manifest" or "uniform manifest" means the combination of Nuclear Regulatory Commission Forms 540, 541, and, if necessary, 542, and their respective continuation sheets as needed, or equivalent.
1833 1834 1835 1836 1837	"Waste collector" means an entity, operating under a Nuclear Regulatory Commission or Agreement State license, whose principal purpose is to collect and consolidate waste generated by others, and to transfer this waste, without processing or repackaging the collected waste, to another licensed waste collector, licensed waste processor, or licensed land disposal facility.

1838	"Waste description" means the physical, chemical and radiological description of a low-
1839	level radioactive waste as called for in Form 541.
1840	"Waste generator" means an entity, operating under a Nuclear Regulatory Commission
1841	or Agreement State license, who (1) possesses any material or component that contains
1842	radioactivity or is radioactively contaminated for which the licensee foresees no further
1843	use, and (2) transfers this material or component to a licensed land disposal facility or to
1844	a licensed waste collector or processor for handling or treatment prior to disposal. A
1845	licensee performing processing or decontamination services may be a "waste generator"
1846	if the transfer low-level radioactive waste from the facility is defined as "residual waste".
1847	"Waste processor" means an entity, operating under a Nuclear Regulatory Commission
1848	or Agreement State license, whose principal purpose is to process, repackage, or
1849	otherwise treat low-level radioactive material or waste generated by others prior to
1850	eventual transfer of waste to a licensed low-level radioactive waste land disposal facility.
1851 1852 1853	"Waste type" means a waste within a disposal container having a unique physical description (that is, a specific waste descriptor code or description, or a waste sorbed on or solidified in a specifically defined media).
1854	II. Information requirements
1855	A. General information. The shipper of the radioactive waste shall provide the following
1856	information on the uniform manifest:
1857	1. The name, facility address, and telephone number of the licensee shipping the waste;
1858	 An explicit declaration indicating whether the shipper is acting as a waste generator,
1859	collector, processor, or a combination of these identifiers for purposes of the
1860	manifested shipment; and
1861	 The name, address, and telephone number or the name and U.S. Environmental
1862	Protection Agency hazardous waste identification number for the carrier
1863	transporting the waste.
1864 1865	B. Shipment information. The shipper of the radioactive waste shall provide the following information regarding the waste shipment on the uniform manifest:
1866	1. The date of the waste shipment;
1867	2. The total number of packages/disposal containers;
1868	3. The total disposal volume and disposal weight of the shipment;
1869	4. The total radionuclide activity in the shipment;
1870	 The activity of each of the radionuclides H-3, C-14, Tc-99, and I-129 contained in the
1871	shipment; and
1872	The total masses of U-233, U-235, and plutonium in special nuclear material, and the
1873	total mass of uranium and thorium in source material.
1874	C. Disposal container and waste information. The shipper of the radioactive waste shall provide
1875	the following information on the uniform manifest regarding the waste and each disposal
1876	container of waste in the shipment:

1877	 An alphabetic or numeric identification that uniquely identifies each disposal container
1878	in the shipment;
1879	 A physical description of the disposal container, including the manufacturer and model
1880	of any high integrity container;
1881	3. The volume displaced by the disposal container;
1882	4. The gross weight of the disposal container, including the waste;
1883	 For waste consigned to a disposal facility, the maximum radiation level at the surface
1884	of each disposal container;
1885	6. A physical and chemical description of the waste;
1886	 The total weight percentage of chelating agent for any waste containing more than 0.1
1887	% chelating agents by weight, plus the identity of the principal chelating agent;
1888	8. The approximate volume of waste within the container;
1889	 The sorbing or solidification media, if any, and the identity of the solidification media
1890	vendor and brand name;
1891 1892 1893 1894 1895 1896 1897	10. The identities and activities of individual radionuclides contained in each container, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material. For discrete waste types (that is, activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides associated with or contained in these waste types within a disposal container shall be reported;
1898	11. The total radioactivity within each container; and
1899	 For wastes consigned to a disposal facility, the classification as Class A, Class B, or
1900	Class C pursuant to Section I of Appendix 4E. Waste not meeting the structural
1901	stability requirements of Appendix 4E shall be identified.
1902	D. Uncontainerized waste information
1903	The shipper of the radioactive waste shall provide the following information on the
1904	uniform manifest regarding a waste shipment delivered without a disposal container:
1905	1. The approximate volume and weight of the waste;
1906	2. A physical and chemical description of the waste;
1907	 The total weight percentage of chelating agent if the chelating agent exceeds 0.1 % by
1908	weight, plus the identity of the principal chelating agent;
1909	 For wastes consigned to a disposal facility, the classification as Class A, Class B, or
1910	Class C pursuant to Section I of Appendix 4E; Waste not meeting the structural
1911	stability requirements of Appendix 4E shall be identified;

1912	 The identities and activities of individual radionuclides contained in each container, the
1913	masses of U-233, U-235, and plutonium in special nuclear material, and the
1914	masses of uranium and thorium in source material;
1915	For wastes consigned to a disposal facility, the maximum radiation levels at the
1916	surface of the waste.
1917	E. Multi-generator disposal container information
1918	This section applies to disposal containers enclosing mixtures of waste originating from
1919	different generators. The origin of the low-level radioactive waste resulting from a
1920	processor's activities may be attributable to one or more "generators," including "waste
1921	generators," as defined in this Part. This section also applies to mixtures of wastes
1922	shipped in an uncontainerized form, for which portions of the mixture within the shipment
1923	originate from different generators.
1924	 For homogeneous mixtures of waste, such as incinerator ash, provide the waste
1925	description applicable to the mixture and the volume of the waste attributed to
1926	each generator.
1927 1928 1929 1930 1931 1932	2. For heterogenous mixtures of waste, such as the combined products from a large compactor, identify each generator contributing waste to the disposal container, and, for discrete waste types (that is, activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification stabilization media), the identities and activities of individual radionuclides associated with or contained on these waste types within a disposal container.
1933	For each generator, provide the following:
1934	1. The volume of waste within the container
1935	 A physical and chemical description of the waste, including the solidification agent, if
1936	any;
1937	 The total weight percentage of chelating agent for any disposal container containing
1938	more than 0.1% chelating agents by weight, plus the identity of the principal
1939	chelating agent;
1940	 The sorbing or solidification media, if any, and the identity of the solidification media
1941	vendor and brand name if the media is claimed to meet stability requirements in
1942	Appendix 4E;
1943	 Radionuclide identities and activities contained in the waste, the masses of U 233, U-
1944	235, and plutonium in special nuclear material, and the masses of uranium and
1945	thorium in source material if contained in the waste.
1946	III. Certification
1947	An authorized representative of the waste generator, collector or processor shall certify by signing
1948	and dating the shipment manifest that the transported materials are properly classified, described,
1949	packaged, marked, and labeled and are in proper condition for transportation according to the
1950	applicable regulations of the Department of Transportation and the Department. A collector in
1951	signing the certification is certifying that nothing has been done to the collected waste which
1952	would invalidate the waste generator's certification.

1953	IV. Control and tracking
1954	A. Any license who transfers radioactive waste to a land disposal facility or a licensed waste
1955	collector shall comply with the requirements in IV.A.1. through IV.A.9. of this section. Any
1956	licensee who transfers waste to a licensed waste processor for waste treatment or
1957	repackaging shall comply with the requirements of IV.A.4. through IV.A.9. of this section.
1958	A licensee shall:
1959	 Prepare all wastes so that the waste is classified according to Section I of Appendix
1960	4E and meets the waste characteristics requirements in Section II of Appendix
1961	4E;
1962	 Label each disposal container (or transport package if potential radiation hazards
1963	preclude labeling of the individual disposal container) of waste to identify whether
1964	it is Class A waste, Class B waste, or Class C waste, in accordance with Section
1965	I of Appendix 4E;
1966	 Conduct a quality assurance program to ensure compliance with Sections I and II of
1967	Appendix 4E; the program shall include management evaluation of audits;
1968	4. Prepare the uniform manifest as required by this appendix;
1969	Forward a copy or electronically transfer the uniform manifest to the intended
1970	consignee so that either:
1971	a. Receipt of the manifest precedes the low-level radioactive waste shipment or
1972	 b. The manifest is delivered to the consignee with the waste at the time the
1973	waste is transferred to the consignee. Using both (a) and (b) is also
1974	acceptable;
1975	 Include Form 540 (and Form 540a, if required) with the shipment regardless of the
1976	option chosen in Section IV.A.5.;
1977	 Receive acknowledgement of the receipt of the shipment in the form of a signed copy
1978	of Form 540;
1979	 Retain a copy of or electronically store the uniform manifest and documentation of
1980	acknowledgment of receipt as the record of transfer of licensed material as
1981	required by 3.22 of these regulations; and
1982	 For any shipments or any portion of a shipment for which acknowledgment of receipt
1983	has not been received within the times set forth in this appendix, conduct an
1984	investigation in accordance with Section V.
1985	B. Any waste collector licensee who handles only prepackaged waste shall:
1986	 Acknowledge receipt of the waste from the shipper within 1 week of receipt by
1987	returning a signed copy of Form 540;
1988	 Prepare a new manifest to reflect consolidated shipments that meet the requirements
1989	of this appendix. The waste collector shall ensure that, for each container of
1990	waste in the shipment, the manifest identifies the generator of that container of
1991	waste;

1992 1993 1994 1995 1996	3. Forward a copy or electronically transfer the uniform manifest to the intended consignee so that either: (i) receipt of the manifest precedes the low-level radioactive waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
1997	 Include Form 540 (and Form 540a, if required) with the shipment regardless of the
1998	option chosen in Section IV.B.3.;
1999	 Receive acknowledgement of the receipt of the shipment in the form of a signed copy
2000	of Form 540;
2001	 Retain a copy of or electronically store the uniform manifest and documentation of
2002	acknowledgment of receipt as the record of transfer of licensed material as
2003	required by 3.22 of these regulations; and
2004	 For any shipments or any portion of a shipment for which acknowledgment of receipt
2005	has not been received within the times set forth in this appendix, conduct an
2006	investigation in accordance with Section V.
2007	8. Notify the shipper and the department when any shipment, or part of a shipment, has
2008	not arrived within 60 days after receipt of an advance manifest, unless notified by
2009	the shipper that the shipment has been cancelled.
2010	C. Any licensed waste processor who treats or repackages wastes shall:
2011	 Acknowledge receipt of the waste from the shipper within 1 week of receipt by
2012	returning a signed copy of Form 540;
2013	 Prepare a new manifest that meet the requirements of this appendix. Preparation of
2014	the new manifest reflects that the processor is responsible for meeting these
2015	requirements. For each container of waste in the shipment, the manifest shall
2016	identify the waste generators, the preprocessed waste volume, and the other
2017	information required in Section II.E of this appendix;
2018	 Prepare all wastes so that the waste is classified according to Appendix 4E and meets
2019	the waste characteristics requirements in Section I of Appendix 4E;
2020	 Label each package of waste to identify whether is Class A waste, Class B waste, or
2021	Class C waste in accordance with Appendix 4E;
2022	 Conduct a quality assurance program to ensure compliance with Sections I and II of
2023	Appendix 4E; the program shall include management evaluation of audits;
2024	Forward a copy or electronically transfer the uniform manifest to the intended
2025	consignee so that either:
2026	a. Receipt of the manifest precedes the low-level radioactive waste shipment or
2027	 b. The manifest is delivered to the consignee with the waste at the time the
2028	waste is transferred to the consignee. Using both (a) and (b) is also
2029	acceptable;
2030	 Include Form 540 (and Form 540a, if required) with the shipment regardless of the
2031	option chosen in IV.C.6;

2032 2033	 Receive acknowledgement of the receipt of the shipment in the form of a signed copy of Form 540; 	
2034 2035 2036	 Retain a copy of or electronically store the uniform manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 3.22 of these regulations; and 	
2037 2038 2039	10. For any shipments or any portion of a shipment for which acknowledgment of receipt has not been received within the times set forth in this appendix, conduct an investigation in accordance with Section V.	
2040 2041 2042	11. Notify the shipper and the Department when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been cancelled.	
2043	D. The land disposal facility operator shall:	
2044 2045 2046 2047 2048 2049	 Acknowledge receipt of the waste within 1 week of receipt by returning, as a minimum, a signed copy of Form 540 to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. If any discrepancy exists between materials listed on the uniform manifest and materials received, copies or electronic transfer of the affected forms must be returned indicating the discrepancy; 	
2050 2051	 Maintain copies of all completed manifests and electronically store the information required by Part 14 of these Regulations until license termination; 	
2052 2053 2054	 Notify the shipper and the Department when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been cancelled. 	
2055 2056	V. Any shipment or part of a shipment for which acknowledgement is not received within the times set forth in this section shall:	
2057 2058	A. Be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and	
2059 2060 2061	B. Be traced and reported. The investigation shall include tracing the shipment and filing a report with the Department. Each licensee who conducts a trace investigation shall file a written report with the Department within 2 weeks of completion of the investigation.	
2062 2063 2064	C. Notify the shipper and the Department when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been cancelled.	
2065 2066	PART 4 APPENDIX 4E: CLASSIFICATION AND CHARACTERISTICS OF LOW-LEVEL RADIOACTIVE WASTE	Comment [JJ41]: The addition of "4" corrects a prior omission. Appendix "4E" is referenced multiple times throughout Part 4. (Previously, this appendix was incorrectly labeled only as "E").
2067	CLASSIFICATION AND CHARACTERISTICS OF LOW-LEVEL RADIOACTIVE WASTE	
2068	I. Classification of Radioactive Waste for Land Disposal	
2069 2070 2071	A. Considerations. Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides (and their shorter-lived precursors) whose potential hazard will persist long	

C-14 in activated metal

C-14

Ni-59 in activated metal

Nb-94 in activated metal

I-129

2072 2073 2074	after such preca disposal have ce radionuclides co	utions as institutional controls, in eased to be effective. These prec	nproved waste form, and deeper autions delay the time when long the magnitude of the potential d	J-lived				
2075	limited by the concentration and availability of the radionuclide at the time of exposure.							
2070 2077 2078	for which require effective.	ements on institutional controls, w	vaste form, and disposal methods	s are				
2079	B. Classes of waste.							
2080 2081 2082 2083 2084	1. Class A wast disposal the minii the stab the wast	e is waste that is usually segrega site. The physical form and char mum requirements set forth in Se ility requirements set forth in Sec te for disposal.	ated from other waste classes at f acteristics of Class A waste mus ection II.A. If Class A waste also i tion II.B. It is not necessary to se	the t meet meets gregate				
2085 2086 2087 2088	 Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in Section II. 							
2089	3. Class C waste is waste that not only must meet more rigorous requirements on waste							
2090	facility to	protect against inadvertent intru	ision. The physical form and stability	sai				
2092	requiren	nents set forth in Section II.		у				
2094 2095	C. Classification determined by long-lived radionuclides. If the radioactive waste contains only radionuclides listed in Table 4FB1 classification shall be determined as follows:							
2096	1. If the concent	tration does not exceed 0.1 times	s the value in Table 4 E B1, the wa	aste is	multiple references throughout Appendix 4E, where tables 4E should have been referenced rather than			
2097	Class A.							
2098 2099	 If the concentration exceeds 0.1 times the value in Table 4EB1, but does not exceed the value in Table 4EB1, the waste is Class C. 							
2100 2101	 If the concentration exceeds the value in Table 4EB1, the waste is not generally acceptable for land disposal. 							
2102	4. For wastes containing mixtures of radionuclides listed in Table 4EB1, the total							
2105	Concentration shall be determined by the sum of fractions rule described in Section I.G. of this appendix.							
2105	TABLE	4 E 1						
	•	Concentration	Concentration					
	Radionuclide	curie/cubic meter ^k	nanocurie/gram ¹					
		(Ci/m ³)	(nCi/g)					

.

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80

8

220

0.2

0.08

	Tc-99 3						
	Alpha-emitting		10)0			
	transuranic radionuclide	es					
	with half-life greater that	an					
	five years						
	Cm-242		20,0	000			
	Ra-226	100	·				
	Pu-241	3,500					
2106							
2107	k To convert the Ci/m3 values to give	gabecquerel (GBq) per cubic mete	er, multiply the Ci/m3 value by 37.				
2108	I To convert the nCi/g values to bec	querel (Bq) per gram, multiply the	nCi/g value by 37.				
2109	D. Classification de	termined by short-lived rad	ionuclides.				
2110	If the waste	does not contain any of the	e radionuclides listed in Tak	ble 4 EB1. classification			
2111	shall be dete	ermined based on the conc	entrations shown in Table	4EB2. However, as			
2112	specified in	Section I.F. of this appendi	x, if radioactive waste does	s not contain any			
2115	11นปแนษอ แอน		TADIE 4 COZ, IL IS UIDS π .				
2114	1. If the cor	ncentration does not exceed	d the value in Column 1, th	e waste is Class A.			
2115	2. If the cor	ncentration exceeds the val	ue in Column 1 but does n	ot exceed the value in			
2116	Column 2, the waste is Class B.						
2117	3. If the concentration exceeds the value in Column 2 but does not exceed the value in						
2118	Column 3, the waste is Class C.						
2110							
2119 2120	If the concentration exceeds the value in Column 3, the waste is not generally accentable for near-surface disposal						
2120			iposai.				
2121	5. For wast	es containing mixtures of th	ne radionuclides listed in Ta	able 4 <mark>EB</mark> 2, the total			
2122	con	centration shall be determin	ned by the sum of fractions	rule described in			
2123	360	ition i.g.					
2124	TAE	3LE <mark>4E</mark> 2					
	Radionuclide	Concentration,	curie/cubic meter*	curie/cubic meter*			
	•	Column 1	Column 2	Column 3			
	Total of all	700	*	*			
	radionuclides with						
	less than 5-year half-						
	life						
	Co-60	700	*	*			
	Cs-137	1	44	4600			
	H-3	40	*				
	Ni-63	3.5	3.5 70 74				
	Ni-63 in activated	35	700	7000			
	metal						
	Sr-90	0.04	150	7000			

2125	
2126 2127 2128 2129 2130	*Department Note: To convert the Ci/m3 value to gigabecquerel (GBq) per cubic meter, multiply the Ci/m3 value by 37. There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in Table 4EB2 determine the waste to be Class C independent of these radionuclides.
2131 2132 2133	E. Classification determined by both long- and short-lived radionuclides. If the radioactive waste contains a mixture of radionuclides, some of which are listed in Table 4EB1 and some of which are listed in Table 4EB2, classification shall be determined as follows:
2134 2135 2136	 If the concentration of a radionuclide listed in Table 4EB1 is less than 0.1 times the value listed in Table 4EB1, the class shall be that determined by the concentration of radionuclides listed in Table 4EB2.
2137 2138 2139 2140	 If the concentration of a radionuclide listed in Table 4EB1 exceeds 0.1 times the value listed in Table 4EB1, but does not exceed the value in Table 4EB1, the waste shall be Class C, provided the concentration of radionuclides listed in Table 4EB2 does not exceed the value shown in Column 3 of Table 4EB2.
2141 2142 2143	F. Classification of wastes with radionuclides other than those listed in Table 4EB1 and Table 4EB2. If the waste does not contain any radionuclides listed in either Table 4EB1 or Table 4EB2, it is Class A.
2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154	G. The sum of the fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column. Example: A waste contains Sr-90 in a concentration of 1.85 TBq/m ³ (50 Ci/m ³) and Cs-137 in a concentration of 814 GBq/m ³ (22 Ci/m ³). Since the concentrations both exceed the values in Column 1, Table 4EB2, they must be compared to Column 2 values. For Sr-90 fraction, 50/150 = 0.33, for Cs-137 fraction, 22/44 = 0.5; the sum of the fractions = 0.83. Since the sum is less than 1.0, the waste is Class B.
2155 2156 2157 2158 2159 2160 2161	H. Determination of concentrations in wastes. The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as becquerel (microcurie) per gram.
2162	II. Radioactive Waste Characteristics
2163 2164	A. The following are minimum requirements for all classes of waste and are intended to facilitate handling and provide protection of health and safety of personnel at the disposal site.
2165 2166 2167 2168	 Wastes shall be packaged in conformance with the conditions of the license issued to the site operator to which the waste will be shipped. Where the conditions of the site license are more restrictive than the provisions of Part 4, the site license conditions shall govern.
2169	2. Wastes shall not be packaged for disposal in cardboard or fiberboard boxes.

2170	 Liquid waste shall be packaged in sufficient absorbent material to absorb twice the
2171	volume of the liquid.
2172	 Solid waste containing liquid shall contain as little free-standing and non-corrosive
2173	liquid as is reasonably achievable, but in no case shall the liquid exceed 1 % of
2174	the volume.
2175	 Waste shall not be readily capable of detonation or of explosive decomposition or
2176	reaction at normal pressures and temperatures, or of explosive reaction with
2177	water.
2178 2179 2180 2181	6. Waste shall not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste. This does not apply to radioactive gaseous waste packaged in accordance with Section II.A.8.
2182	 Waste must not be pyrophoric. Pyrophoric materials contained in wastes shall be
2183	treated, prepared, and packaged to be nonflammable.
2184	 Wastes in a gaseous form shall be packaged at an absolute pressure that does not
2185	exceed 1.5 atmospheres at 20° C. Total activity shall not exceed 3.7 TBq (100
2186	Ci) per container.
2187	 Wastes containing hazardous, biological, pathogenic, or infectious material shall be
2188	treated to reduce to the maximum extent practicable the potential hazard from
2189	the non-radiological materials.
2190	B. The following requirements are intended to provide stability of the waste. Stability is intended
2191	to ensure that the waste does not degrade and affect overall stability of the site through
2192	slumping, collapse, or other failure of the disposal unit and thereby lead to water
2193	infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder, since it
2194	provides a recognizable and nondispersible waste.
2195 2196 2197 2198 2199 2200 2201	1. Waste shall have structural stability. A structurally stable waste form will generally maintain its physical dimensions and its form, under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, and microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.
2202 2203 2204 2205 2206 2207	2. Notwithstanding the provisions in Section II.A.3. and II.A.4., liquid wastes, or wastes containing liquid, shall be converted into a form that contains as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1 % of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5% of the volume of the waste for waste processed to a stable form.
2208	 Void spaces within the waste and between the waste and its package shall be
2209	reduced to the extent practicable.
2210	III. Labeling.
2211 2212	Each package of waste shall be clearly labeled to identify whether it is Class A, Class B, or Class C waste, in accordance with Section I.

2213	PART 4. APPENDIX 4F:	QUANTITIES FOR USE WITH DECOMMISS	IONING
2215			

2214	QUANTITIES FOR USE WITH DEC Material	COMMISSIONING Microcurie*
	Americium-241	0.01
	Antimony-122	100
	Antimony-124	10
	Antimony-125	10
	Arsenic-73	100
	Arsenic-74	10
	Arsenic-76	10
	Arsenic-77	100
	Barium-131	10
	Barium-133	10
	Barium-140	10
	Bismuth-210	1
	Bromine-82	10
	Cadmium-109	10
	Cadmium-115	100
	Cadmium-115m	10
	Calcium-45	10
	Calcium-47	10
	Carbon-14	100
	Cerium-141	100
	Cerium-143	100
	Cerium-144	1
	Cesium-131	1,000
	Cesium-134	1
	Cesium-134m	100
	Cesium-135	10
	Cesium-136	10
	Cesium-137	10
	Chlorine-36	10
	Chlorine-38	10
	Chromium-51	1,000
	Cobalt-58	10
	Cobalt-58m	10
	Cobalt-60	1
	Copper-64	100
	Dysprosium-165	10
	Dysprosium-166	100
	Erbium-169	100
	Erbium-171	100
	Europium-152 (13 yr)	1
	Europium-152 (9.2 h)	100
	Europium-154	1
	Europium-155	10

Florine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	100
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1.000
Indium-113m	100
Indium-114m	10
Indium-115	10
Indium-115m	100
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	100
Krypton-87	10
Lanthanum-140	10
Lutetium-177	100
Manganese-52	10
Manganese-54	10
Manganese-56	10
Mercury-197	100
Mercury-197m	100
Mercury-203	10
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10

Osmium-191	100
Osmium-191m	100
Osmium-193	100
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100
Platinum-193	100
Platinum-193m	100
Platinum-197	100
Platinum-197m	100
Plutonium-239	0.01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	0.01
Rhenium-186	100
Rhenium-188	100
Rhodium-103m	100
Rhodium-105	100
Rubidium-86	10
Rubidium-87	10
Ruthenium-103	10
Ruthenium-105	10
Ruthenium-106	1
Ruthenium-97	100
Samarium-151	10
Samarium-153	100
Scandium-46	10
Scandium-47	100
Scandium-48	10
Selenium-75	10
Silicon-31	100
Silver-105	100
Silver-111	100
Silver-110m	100
Sodium-22	1
Sodium 24	10
Strontium 85	10
Strontium-89	10
Strontium_00	1 0 1
Strontium 01	10
Strontium 02	10
Suonnun-92	10

Sulfur -35	100
Tantalum-182	10
Technetium-96	10
Technetium-97	100
Technetium-97m	100
Technetium-99	10
Technetium-99m	100
Tellurium-125m	10
Tellurium-127	100
Tellurium-127m	10
Tellurium-129	100
Tellurium-129m	10
Tellurium-131m	10
Tellurium-132	10
Terbium-160	10
Thallium-200	100
Thallium-201	100
Thallium-202	100
Thallium-204	10
Thorium (natural)**	100
Thulium-170	10
Thulium-171	10
Tin-113	10
Tin-125	10
Tungsten-181	10
Tungsten-185	10
Tungsten-187	100
Uranium (natural)***	100
Uranium-233	0.01
Uranium-234	0.01
Uranium-235	0.01
Vanadium-48	10
Xenon-131m	1.000
Xenon-133	100
Xenon-135	100
Ytterbium-175	100
Yttrium-90	10
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Zinc-65	10
Zinc-69	1.000
Zinc-69m	100
Zirconium-93	10
Zirconium-95	10
Zirconium-97	10

Any alpha emitting	0.01
radionuclide not listed	
above or mixtures of	
alpha emitters of	
unknown composition	
Any radionuclide other	0.1
than alpha emitting	
radionuclides, not listed	
above or mixtures of beta	
emitters of unknown	
composition	
[*] To convert µCi to kBq,	
multiply the μ Ci value by	
37.	
** Based on alpha	
disintegration rate of Th-	
232, Th-230 and their	
decay products.	
*** Based on alpha	
disintegration rate of U-	
238, U-234, and U-235.	

2215

2216 2217 2218 2219 Note: Where there is involved a combination of isotopes in known amounts, the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" — that is, 2220 unity.

2221 PART 4, APPENDIX 4G: NATIONALLY TRACKED SOURCE THRESHOLDS

2222 2223 2224 The Terabecquerel (TBq) values are the regulatory standard. The curie (Ci) values specified are obtained by converting the TBq value. The Curie (Ci) values are provided for practical usefulness only and are rounded after conversion.

Radioactive material	Category 1	Category 1	Category 2	Category 2
Actinium-227	(ТВД)		(твq)	
	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
Curium-244	50	1,400	0.5	14

Comment [JJ43]: This is a new Appendix and new table for Part 4. As noted in earlier comments [SEE comments pertaining to Section 4.55], the requirements are not new but have been implemented through legally binding license condition for certain licenses.

The table is added for consistency with Appendix E of 10 CFR Part 20. The table is used in conjunction with Part 1 (Nationally Tracked Source definition), and Section 4.55 of this Part.

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Cesium-137	100	2,700	1	27
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

2225

2226

2227 EDITOR'S NOTES

6 CCR 1007-1 has been divided into smaller sections for ease of use. Versions prior to 4/1/07 and rule

history are located in the first section, 6 CCR 1007-1. Prior versions can be accessed from the History link that appears above the text in 6 CCR 1007-1. To view versions effective on or after 4/1/07, Select the

2228 2229 2230 2231

desired part of the rule, for example 6 CCR 1007-1 Part 1 or 6 CCR 1007-1 Parts 8 - 10.

2232 History

2233 [For history of this section, see Editor's Notes in the first section, 6 CCR 1007-1]

DRAFT B – 10/25/2012

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1	Col. 2	Col. 3Col. 1	Col. 1	Col. 2	
			Indestion	Inhala	ation			Average
Atomic	Radionuclide	Class	ALI	ALI	DAC	Air	Water	Concentration
No.			(μCi)	(μCi)	(µCi/ml)	(µCi/ml)	(µCi/ml)	(µCi/ml)
89	Actinium-224	D, all compounds except	25.2	25.1	1 - 0			
		those given for w and f	ZE+3	Bone surf	12-0	-	-	-
			(2E+3)	(4E+1)	-	5E-11	3E-5	3E-4
		W, halides and nitrates	-	5E+1	2E-8	7E-11	-	-
		Y, oxides and hydroxides	-	5E+1	2E-8	6E-11	-	-
89	Actinium-225	D see 224Ac	5E+1	3E-1	1E-10	-	-	-
00		2,300 /10	LLI wall	Bone surf	12 10			
			(5E+1)	(5E-1)	-	7E-13	7E-7	7E-6
		W, see 224 Ac	-	6E-1	3E-10	9E-13	-	-
		Y, see ²² Ac	-	6E-1	3E-10	9E-13	-	-
89	Actinium-226	D, see ²²⁴ Ac	1E+2	3E+0	1E-9	-	-	-
		_,	LLI wall	Bone surf				
		224	(1E+2)	(4E+0)		5E-12	2E-6	2E-5
		W, see ²²⁴ Ac	-	5E+0	2E-9	7E-12	-	-
		Y, see ²²³ Ac	-	5E+0	2E-9	6E-12	-	-
89	Actinium-227	D, see ²²⁴ Ac	2E-1	4E-4	2E-13	-	-	-
		_,	Bone surf	Bone surf				
		224	(4E-1)	(8E-4)		1E-15	5E-9	5E-8
		W, see ²²⁴ Ac	-	2E-3	7E-13	-	-	-
				Bone Surr		15 15		
		Y, see ²²⁴ Ac	-	4E-3	- 2E-12	6E-15		
		.,		.2 0		02.10		
89	Actinium-228	D, see ²²⁴ Ac	2E+3	9E+0	4E-9	-	3E-5	3E-4
				Bone surf		2E 11		
		W see 224Ac	-	(2E+1) 4E+1	- 2E-8	20-11	-	-
		W, 300 / 10		Bone surf	22.0			
			-	(6E+1)	-	8E-11	-	-
		Y, see ²²⁴ Ac	-	4E+1	2E-8	6E-11	-	-
13	Aluminum-26	D all compounds except						
13	Autominum-20	those given for W	4F+2	6E+1	3E-8	9E-11	6F-6	6E-5
			7672	UL II			OL O	
		W, oxides, hydroxides,						
		carbides, halides, and		05.4	45.0	45.40		
		nitrates	-	9E+1	4E-8	1E-10	-	-

Comment [JJ1]: The primary purpose of changes to these tables is:

1.. To make formatting and alignment changes to the header and footer of the document for clarity and consistency.

2.Add values for the radionuclides Nitrogen and Oxygen for consistency and compatibility with 10 CFR 20, Appendix B. [Refer to later sections in this document for further details on these isotopes.] No other values were changed in this table.

EDITORIAL NOTE: The page number in the footer of this Appendix will be modified to match and coordinate with the page numbers contained in the main body of the regulation once the finalized regulation is formatted and redline text is removed.

Atomic No.	Radionuclide	Class	Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (µCi)	Col. 2	Col. 3 Col. 1	Col. 1 Col. 2 Air Water (μCi/ml) (μCi/ml)	Col. 2	Monthly
				ALI (μCi)	DAC (μCi/ml)		Concentration (μCi/ml)	
95	Americium-237 ²	W, all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2
95	Americium-238 ²	W, all compounds	4E+4 -	3E+3 Bone surf (6E+3)	1E-6 -	- 9E-9	5E-4 -	5E-3 -
95	Americium-239	W, all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
95	Americium-240	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
95	Americium-241	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
95	Americium-242	W, all compounds	4E+3	8E+1 Bone surf (9E+1)	4E-8	- 1E-10	5E-5 -	5E-4 -
95	Americium-242m	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
95	Americium-243	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
95	Americium-244	W, all compounds	3E+3	2E+2 Bone surf (3E+2)	8E-8	- 4F-10	4E-5 -	4E-4
95	Americium-244m ²	W, all compounds	6E+4 St wall	4E+3 Bone surf (7E+2)	2E-6	-	-	-
95	Americium-245	W all compounds	(oE+4) 3E+4	(7 ⊑+3) 8F+4	- 3E-5	1E-0 1E-7	1E-3 4E-4	1E-2 4E-3
95	Americium-246 ²	W all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
95	Americium-246m ²	W, all compounds	5E+4 St wall	2E+5	8E-5	3E-7	- 8E-4	- 8E-3

I
I					Table 4B1 Occupational Values		Tabl Eff Concer	e 4B2 luent htrations	Table 4B3 Releases to Sewers
				Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
I	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (μCi/ml)
	51	Antimony-115 ²	D, all compounds except those given for W	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
			W, oxides, hydroxides, halides, sulfides, sulfates, and nitrates	-	3E+5	1E-4	4E-7	-	-
	51	Antimony-116 ²	D, see ¹¹⁵ Sb	7E+4	3E+5	1E-4	4E-7	-	-
			W, see ¹¹⁵ Sb	(9E+4) -	- 3E+5	- 1E-4	- 5E-7	1E-3 -	1E-2 -
	51	Antimony-116m ²	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	2E+4 -	7E+4 1E+5	3E-5 6E-5	1E-7 2E-7	3E-4 -	3E-3 -
	51	Antimony-117	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	7E+4	2E+5 3E+5	9E-5 1E-4	3E-7 4E-7	9E-4 -	9E-3 -
	51	Antimony-118m	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	6E+3 5E+3	2E+4 2E+4	8E-6 9E-6	3E-8 3E-8	7E-5 -	7E-4
	51	Antimony-119	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	2E+4 2E+4	5E+4 3E+4	2E-5 1E-5	6E-8 4E-8	2E-4 -	2E-3
	51	Antimony-120 (5.76 d)	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	1E+3 9E+2	2E+3 1E+3	9E-7 5E-7	3E-9 2E-9	1E-5 -	1E-4 -
	51	Antimony-120 ²	D, see ¹¹⁵ Sb	1E+5	4E+5	2E-4	6E-7	-	-
		(10 1111)	W, see ¹¹⁵ Sb	(2E+5)	- 5E+5	- 2E-4	- 7E-7	2E-3	2E-2
	51	Antimony-122	D, see ¹¹⁵ Sb	8E+2	2E+3	1E-6	3E-9	-	-
			W, see ¹¹⁵ Sb	(8E+2) 7E+2	- 1E+3	- 4E-7	- 2E-9	1E-5 -	1E-4 -
	51	Antimony-124	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	6E+2 5E+2	9E+2 2E+2	4E-7 1E-7	1E-9 3E-10	7E-6 -	7E-5 -
	51	Antimony-124m ²	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	3E+5 2E+5	8E+5 6E+5	4E-4 2E-4	1E-6 8E-7	3E-3 -	3E-2 -
	51	Antimony-125	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	2E+3	2E+3 5E+2	1E-6 2E-7	3E-9 7E-10	3E-5 -	3E-4

				Table 4B1 Occupational Values		Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
51	Antimony-126	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	6E+2 5E+2	1E+3 5E+2	5E-7 2E-7	2E-9 7E-10	7E-6	7E-5
51	Antimony-126m ²	D, see ¹¹⁵ Sb	5E+4	2E+5	8E-5	3E-7	-	-
		W, see ¹¹⁵ Sb	(7E+4) -	- 2E+5	- 8E-5	- 3E-7	9E-4 -	9E-3 -
51	Antimony-127	D, see ¹¹⁵ Sb	8E+2	2E+3	9E-7	3E-9	-	-
		W, see ¹¹⁵ Sb	(8E+2) 7E+2	- 9E+2	- 4E-7	- 1E-9	1E-5 -	1E-4
51	Antimony-128 (9.01 h)	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	1E+3 -	4E+3 3E+3	2E-6 1E-6	6E-9 5E-9	2E-5 -	2E-4 -
51	Antimony-128 ² (10.4 min)	D, see ¹¹⁵ Sb	8E+4 St wall	4E+5	2E-4	5E-7	-	-
	()	W, see ¹¹⁵ Sb	(1E+5)	- 4E+5	- 2E-4	- 6E-7	1E-3 -	1E-2 -
51	Antimony-129	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	3E+3 -	9E+3 9E+3	4E-6 4E-6	1E-8 1E-8	4E-5 -	4E-4 -
51	Antimony-130 ²	D, see ¹¹⁵ Sb W, see ¹¹⁵ Sb	2E+4 -	6E+4 8E+4	3E-5 3E-5	9E-8 1E-7	3E-4 -	3E-3 -
51	Antimony-131 ²	D, see ¹¹⁵ Sb	1E+4 Thyroid	2E+4 Thyroid	1E-5	-	-	-
		W, see ¹¹⁵ Sb	(2E+4) -	(4E+4) 2E+4 Thyroid	- 1E-5	6E-8	2E-4 -	2E-3 -
			-	(4E+4)	-	6E-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	-	-

				Table 4B1 Occupational Values	5	Tabl Eff Concer	le 4B2 luent ntrations	Table 4B3 Releases to Sewers
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Nonthly Average Concentration (μCi/ml) - 6E-3 2E-3 5E-4 1E-3 2E-4 1E-3 2E-4 1E-3 2E-4 1E-3 2E-4 1E-3 2E-4 1E-3 2E-4 1E-4 - 6E-4 1E-3 8E-4 - 2E-5 - 8E-4 - 7E-5 4E-4 - 7E-2 2E-1
33	Arsenic-69 ²	W, all compounds	3E+4 St wall	1E+5	5E-5	2E-7	-	-
			(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
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 LLI wall	5E+3	2E-6	7E-9	-	-
33	Arsenic-78 ²	W all compounds	(3E+3) 8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
85	Astatine-207 ²	D, halides W	6E+3 -	3E+3 2E+3	1E-6 9E-7	4E-9 3E-9	8E-5	8E-4
85	Astatine-211	D, halides W	1E+2 -	8E+1 5E+1	3E-8 2E-8	1E-10 8E-11	2E-6 -	2E-5
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-131	D, all compounds	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
56	Barium-131m ²	D, all compounds	4E+5 St wall	1E+6	6E-4	2E-6	-	-
50	Deriver 422	D. ell compounds	(3E+3)	-	-	-	/E-3	7E-2
90	Barlum-133	D, all compounds	2E+3	7 = +2	35-7	9E-10	2⊑-5	20-4
56	Barium-133m	D, all compounds	2E+3 LLI wall (3E+3)	9E+3 -	4E-6 -	1E-8 -	- 4E-5	- 4E-4
56	Barium-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

			Table 4B1 Occupational Values			Table 4B2 Table 4B3 Effluent Releases to Concentrations Sewers Col. 1 Col. 2 Monthly Average Air Water	Table 4B3 Releases to Sewers	
			Col. 1 Oral Ingestion	Col. 2 Inhala	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
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
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	-	-	-
			(1E+0)	(9E-3)	-	1E-14	2E-8	2E-7
97	Berkelium-249	W, all compounds	2E+2	2E+0	7E-10	-	-	-
			(5E+2)	(4E+0)	-	5E-12	6E-6	6E-5
97	Berkelium-250	W, all compounds	9E+3	3E+2	1E-7	-	1E-4	1E-3
			-	(7E+2)	-	1E-9	-	-
4	Beryllium-10	W, see ⁷ Be	1E+3	2E+2	6E-8	2E-10	-	-
		Y see ⁷ Be	(1E+3)	- 1F+1	- 6E-9	- 2E-11	2E-5	2E-4
4	Beryllium-7	W, all compounds except	4E+4	2E+4	9E-6	3E-8	6E-4	6E-3
		Y, oxides, halides, and nitrates	-	2E+4	8E-6	3E-8	-	-

				Table 4B1 Occupational Values		Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers Monthly Average Concentration (μCi/ml) 4E-3 - 2E-3 - 2E-3 - 2E-4 - 9E-5 - 1E-4 - 8E-6 - 7E-4
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Table 4B3 Releases to Sewers Monthly Average Concentration (μCi/ml) 4E-3 2E-3 2E-3 2E-3 2E-4 9E-5 1E-4 - 8E-6 - 7E-4 - 8E-6 - 7E-4 - 3E-3
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
83	Bismuth-200 ²	D, nitrates W, all other compounds	3E+4	8E+4 1E+5	4E-5 4E-5	1E-7 1E-7	4E-4	4E-3
83	Bismuth-201 ²	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	1E+4	3E+4 4E+4	1E-5 2E-5	4E-8 5E-8	2E-4	2E-3
83	Bismuth-202 ²	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	1E+4 -	4E+4 8E+4	2E-5 3E-5	6E-8 1E-7	2E-4	2E-3 -
83	Bismuth-203	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	2E+3 -	7E+3 6E+3	3E-6 3E-6	9E-9 9E-9	3E-5 -	3E-4 -
83	Bismuth-205	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	1E+3 -	3E+3 1E+3	1E-6 5E-7	3E-9 2E-9	2E-5 -	2E-4
83	Bismuth-206	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	6E+2 -	1E+3 9E+2	6E-7 4E-7	2E-9 1E-9	9E-6 -	9E-5 -
83	Bismuth-207	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	1E+3 -	2E+3 4E+2	7E-7 1E-7	2E-9 5E-10	1E-5 -	1E-4 -
83	Bismuth-210	D, see ²⁰⁰ Bi	8E+2 -	2E+2 Kidneys	1E-7	-	1E-5	1E-4
		W, see ²⁰⁰ Bi	-	(4E+2) 3E+1	- 1E-8	5E-10 4E-11	-	-
83	Bismuth-210m	D, see ²⁰⁰ Bi	4E+1 Kidneys	5E+0 Kidneys	2E-9	-	-	-
		W, see ²⁰⁰ Bi	(6E+1) -	(6E+0) 7E-1	- 3E-10	9E-12 9E-13	8E-7 -	8E-6 -
83	Bismuth-212 ²	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	5E+3 -	2E+2 3E+2	1E-7 1E-7	3E-10 4E-10	7E-5 -	7E-4 -
83	Bismuth-213 ²	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	7E+3 -	3E+2 4E+2	1E-7 1E-7	4E-10 5E-10	1E-4 -	1E-3 -
83	Bismuth-214 ²	D, see ²⁰⁰ Bi	2E+4 St wall	8E+2	3E-7	1E-9	-	-
		W. see ²⁰⁰ Bi	(2E+4) -	- 9E-2	- 4E-7	- 1E-9	3E-4 -	3E-3

			Table 4B1 Occupational Values		ble 4B1 Table 4B2 Table 4B nal Values Effluent Releases Concentrations Sewers		Table 4B2 Effluent Concentrations		
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Table 4B3 Releases to Sewers 	Monthly
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)		
35	Bromine-74 ²	D, see ^{74m} Br	2E+4 St wall	7E+4	3E-5	1E-7	-	-	
		W, see ^{74m} Br	(4E+4) -	- 8E+4	- 4E-5	- 1E-7	5E-4 -	5E-3 -	
35	Bromine-74m ²	D, bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4 St wall	4E+4	2E-5	5E-8	-	-	
		W, bromides of lantha- nides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, TI, 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,	(2E+4)	-	-	-	3E-4	3E-3	
25	Bromino 75 ²	D soo ^{74m} Br	-	4E+4	2E-5	0E-8 7E 9	-	-	
55	biomine-75	W, see ^{74m} Br	St wall (4E+4)	- 5E+4	- 2E-5	- 7E-8	5E-4	5E-3	
35	Bromine-76	D, see ^{74m} Br W, see ^{74m} Br	4E+3 -	5E+3 4E+3	2E-6 2E-6	7E-9 6E-9	5E-5 -	5E-4 -	
35	Bromine-77	D, see ^{74m} Br W, see ^{74m} Br	2E+4 -	2E+4 2E+4	1E-5 8E-6	3E-8 3E-8	2E-4	2E-3 -	
35	Bromine-80 ²	D, see ^{74m} Br	5E+4 St wall	2E+5	8E-5	3E-7	-	-	
		W, see ^{74m} Br	(9E+4) -	- 2E+5	- 9E-5	- 3E-7	1E-3 -	1E-2 -	
35	Bromine-80m	D, see ^{74m} Br W, see ^{74m} Br	2E+4 -	2E+4 1E+4	7E-6 6E-6	2E-8 2E-8	3E-4 -	3E-3 -	
35	Bromine-82	D, see ^{74m} Br W, see ^{74m} Br	3E+3 -	4E+3 4E+3	2E-6 2E-6	6E-9 5E-9	4E-5 -	4E-4	
35	Bromine-83	D, see ^{74m} Br	5E+4 St wall	6E+4	3E-5	9E-8	-	-	
		W, see ^{74m} Br	-	- 6E+4	- 3E-5	- 9E-8	9 ⊏ -4 -	9E-3 -	
35	Bromine-84 ²	D, see ^{74m} Br	2E+4 St wall	6E+4	2E-5	8E-8	-	-	
		W. see ^{74m} Br	(3E+4) -	- 6E+4	- 3E-5	- 9E-8	4 ⊢ -4	4E-3	

			Table 4B1 Occupational Values			Tabl Eff Concer	$ \begin{array}{c c} e \ 4B2 \\ luent \\ trations \\ \hline \hline Col. 2 \\ \hline \hline Col. 2 \\ \hline \hline Col. 2 \\ \hline \hline \\ Monthly \\ Average \\ Concentration \\ (\mu Ci/ml) \\ \hline \\ 3E-4 \\ 3E-4 \\ 3E-3 \\ \hline \\ - \\ - \\ 3E-4 \\ 3E-3 \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\$	
			Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
Atomic No.	Radionuciide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
48	Cadmium-104 ²	D, all compounds except those given for W and Y	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, sulfides, halides, and nitrates Y, oxides and hydroxides	-	1E+5 1E+5	5E-5 5E-5	2E-7 2E-7	-	-
48	Cadmium-107	D, see ¹⁰⁴ Cd W, see ¹⁰⁴ Cd X, see ¹⁰⁴ Cd	2E+4	5E+4 6E+4	2E-5 2E-5	8E-8 8E-8 7E-9	3E-4 -	3E-3 -
48	Cadmium-109	D, see ¹⁰⁴ Cd	- 3E+2 Kidnevs	4E+1 Kidnevs	2E-3 1E-8	-	-	-
		W, see ¹⁰⁴ Cd	(4E+2)	(5E+1) 1E+2 Kidneys	- 5E-8	7E-11 -	6E-6 -	6E-5 -
		Y, see ¹⁰⁴ Cd	-	(1E+2) 1E+2	- 5E-8	2E-10 2E-10	-	-
48	Cadmium-113	D, see ¹⁰⁴ Cd	2E+1 Kidneys (3E+1)	2E+0 Kidneys (3E+0)	9E-10	- 5E-12	- 4E-7	- 4E-6
		W, see ¹⁰⁴ Cd	-	8E+0 Kidneys (1E+1)	3E-9	- 2E-11	-	-
	0 1 1 110	Y, see ¹⁰⁴ Cd	-	1E+1	6E-9	2E-11	-	-
48	Cadmium-113m	D, see Cd	2E+1 Kidneys (4E+1)	2E+0 Kidneys (4E+0)	1E-9 -	- 5E-12	- 5E-7	- 5E-6
		W, see ¹⁰⁴ Cd	-	8E+0 Kidneys (1E+1)	4E-9	- 2E-11	-	-
40	Codmium 115	Y, see ¹⁰⁴ Cd	-	1E+1	5E-9	2E-11	-	-
40	Cadmidin-115		LLI wall (1E+3)	-		-	- 1E-5	- 1E-4
		W, see ¹⁰⁴ Cd Y, see ¹⁰⁴ Cd	-	1E+3 1E+3	5E-7 6E-7	2E-9 2E-9	-	-
48	Cadmium-115m	D, see ¹⁰⁴ Cd	3E+2	5E+1 Kidneys	2E-8	-	4E-6	4E-5
		W, see ¹⁰⁴ Cd Y, see ¹⁰⁴ Cd	-	(8E+1) 1E+2 1E+2	- 5E-8 6E-8	1E-10 2E-10 2E-10	-	-

			Table 4B1 Occupational Values		Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
			Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Table 4B3 Releases to Sewers Monthly Average Concentration (μCi/ml) 6E-4 - 6E-4 - 6E-4 - 6E-4 - 5E-5 - 2E-6 - 3E-7 - 2E-7 - 2E-7 - 2E-7 - 2E-7 - 2E-7
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	
48	Cadmium-117	D, see ¹⁰⁴ Cd W, see ¹⁰⁴ Cd	5E+3 -	1E+4 2E+4	5E-6 7E-6	2E-8 2E-8 2E-8	6E-5 -	6E-4
48	Cadmium-117m	D, see ¹⁰⁴ Cd W, see ¹⁰⁴ Cd Y, see ¹⁰⁴ Cd	5E+3 -	1E+4 2E+4 1E+4	5E-6 7E-6 6E-6	2E-8 2E-8 2E-8 2E-8	- 6E-5 - -	6E-4 -
20	Calcium-41	W, all compounds	3E+3 Bone surf (4E+3)	4E+3 Bone surf (4E+3)	2E-6	5E-9	- 6E-5	-
20	Calcium-45	W, all compounds	(42+0) 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
98	Californium-244 ²	W, all compounds except those given for Y	3E+4 St wall	6E+2	2E-7	8E-10	-	-
		Y, oxides and hydroxides	(3E+4) -	- 6E+2	- 2E-7	- 8E-10	4E-4 -	4E-3 -
98	Californium-246	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	4E+2 -	9E+0 9E+0	4E-9 4E-9	1E-11 1E-11	5E-6 -	5E-5 -
98	Californium-248	W, see ²⁴⁴ Cf	8E+0 Bone surf	6E-2 Bone surf	3E-11	-	-	-
		Y, see ²⁴⁴ Cf	(2E+1) -	(1E-1) 1E-1	- 4E-11	2E-13 1E-13	2E-7 -	2E-6 -
98	Californium-249	W, see ²⁴⁴ Cf	5E-1 Bone surf	4E-3 Bone surf	2E-12	-	-	-
		Y, see ²⁴⁴ Cf	(1E+0) -	(9E-3) 1E-2 Bone surf (1E-2)	- 4E-12	1E-14 - 2E-14	2E-8 -	2E-7 -
98	Californium-250	W, see ²⁴⁴ Cf	1E+0 Bone surf	9E-3 Bone surf	- 4E-12	-	-	-
		Y, see ²⁴⁴ Cf	(2E+0)	(2E-2) 3E-2	- 1E-11	3E-14 4E-14	3E-8 -	3E-7 -
98	Californium-251	W, see ²⁴⁴ Cf	5E-1 Bone surf	4E-3 Bone surf	2E-12	-	-	-
		Y, see ²⁴⁴ Cf	(1E+0) -	(9E-3) 1E-2 Bone surf	- 4E-12	1E-14 -	2E-8 -	2E-7 -
			-	(1E-2)	-	2E-14	-	-

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Table 4B3 Releases to Sewers Monthly Average Concentration (µCi/ml) - 7E-7 - 5E-5 3E-7 - 6E-2 - 3E-4 - 8E-5 - 2E-4 - 3E-4 - 3E-4 - 2E-4 - 3E-4 - 2E-4 - - 3E-4 - </th
98	Californium-252	W, see ²⁴⁴ Cf	2E+0 Bone surf	2E-2 Bone surf	8E-12		-	-
		Y, see ²⁴⁴ Cf	(5E+0)	(4E-2) 3E-2	- 1E-11	5E-14 5E-14	7E-8 -	7E-7 -
98	Californium-253	W, see ²⁴⁴ Cf	2E+2 Bone surf	2E+0	8E-10	3E-12	-	-
		Y, see ²⁴⁴ Cf	(4E+2)	- 2E+0	- 7E-10	- 2E-12	5E-6 -	5E-5 -
98	Californium-254	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	2E+0 -	2E-2 2E-2	9E-12 7E-12	3E-14 2E-14	3E-8 -	3E-7 -
6	Carbon-11 ²	Monoxide Dioxide Compounds	- - 4E+5	1E+6 6E+5 4E+5	5E-4 3E-4 2E-4	2E-6 9E-7 6E-7	- - 6E-3	- - 6E-2
6	Carbon-14	Monoxide Dioxide Compounds	- - 2E+3	2E+6 2E+5 2E+3	7E-4 9E-5 1E-6	2E-6 3E-7 3E-9	- - 3E-5	- - 3E-4
58	Cerium-134	W, all compounds except those given for Y	5E+2 LLI wall	7E+2	3E-7	1E-9	-	-
		Y, oxides, hydroxides, and fluorides	(6E+2) -	- 7E+2	- 3E-7	- 9E-10	8E-6 -	8E-5 -
58	Cerium-135	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	2E+3 -	4E+3 4E+3	2E-6 1E-6	5E-9 5E-9	2E-5 -	2E-4 -
58	Cerium-137	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	5E+4 -	1E+5 1E+5	6E-5 5E-5	2E-7 2E-7	7E-4 -	7E-3 -
58	Cerium-137m	W, see ¹³⁴ Ce	2E+3 LLI wall	4E+3	2E-6	6E-9	-	-
		Y, see ¹³⁴ Ce	(2E+3) -	- 4E+3	- 2E-6	- 5E-9	3E-5 -	3E-4 -
58	Cerium-139	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	5E+3 -	8E+2 7E+2	3E-7 3E-7	1E-9 9E-10	7E-5 -	7E-4
58	Cerium-141	W, see ¹³⁴ Ce	2E+3	7E+2	3E-7	1E-9	-	-
		Y. see ¹³⁴ Ce	(2E+3)	- 6E+2	- 2E-7	- 8E-10	3E-5	3E-4

				Table 4B1 Occupational Values		Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
Atomic No.	Radionuclide	Class	Ingestion ALI (μCi)	ALI (μCi)	alation DAC (μCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Average Concentration (μCi/ml)
58	Cerium-143 LLI wall	W, see ¹³⁴ Ce	1E+3	2E+3	8E-7	3E-9	-	-
		Y, see ¹³⁴ Ce	(1E+3) -	- 2E+3	- 7E-7	- 2E-9	2E-5 -	2E-4 -
58	Cerium-144	W, see ¹³⁴ Ce	2E+2	3E+1	1E-8	4E-11	-	-
		Y, see ¹³⁴ Ce	(3E+2)	- 1E+1	- 6E-9	- 2E-11	3E-6 -	3E-5 -
55	Cesium-125 ²	D, all compounds	5E+4 St wall (9E+4)	1E+5 -	6E-5 -	2E-7	- 1E-3	- 1E-2
55	Cesium-127	D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3
55	Cesium-129	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
55	Cesium-130 ²	D, all compounds	6E+4 St wall	2E+5	8E-5	3E-7	-	-
55	Cosium 131		(12+3)	25+4	15.5	-	25.4	1E-2 2E-2
55	Cesium 132	D, all compounds	26+2	3E+4	7E-5	4L-0	JL-4	3E-3
55	Cesium-134	D, all compounds	3E+3	4E+3	4E-8	2E-10	4Ľ-5 9E-7	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-135	D, all compounds	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
55	Cesium-135m ²	D, all compounds	1E+5	2E+5	8E-5	3E-7	1E-3	1E-2
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 St wall (3E+4)	6E+4	2E-5 -	8E-8 -	- 4E-4	- 4E-3

				Table 4B1 Occupational Values		Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Table 4B3 Releases to Sewers Monthly Average Concentration (μCi/ml) 2E-4 - - 3E-3 - 5E-3 - 5E-3 - 5E-3 - 5E-3 - 5E-3 - 2E-4 - - 2E-4 - - - 2E-4 -
			Oral	Inha	lation			
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr W, chlorides of lantha- nides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, TI, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au,	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		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	-	-
		W, see ³⁶ Cl	(3E+4) -	- 5E+4	- 2E-5	- 6E-8	3E-4 -	3E-3 -
17	Chlorine-39 ²	D, see ³⁶ Cl	2E+4	5E+4	2E-5	7E-8	-	-
		W, see ³⁶ Cl	St wall (4E+4) -	- 6E+4	- 2E-5	- 8E-8	5E-4 -	5E-3 -
24	Chromium-48	D, all compounds except those given for W and Y W, halides and nitrates Y, oxides and hydroxides	6E+3 - -	1E+4 7E+3 7E+3	5E-6 3E-6 3E-6	2E-8 1E-8 1E-8	8E-5 - -	8E-4 - -
24	Chromium-49 ²	D, see ⁴⁸ Cr W, see ⁴⁸ Cr Y, see ⁴⁸ Cr	3E+4 - -	8E+4 1E+5 9E+4	4E-5 4E-5 4E-5	1E-7 1E-7 1E-7	4E-4 - -	4E-3 - -
24	Chromium-51	D, see ⁴⁸ Cr W, see ⁴⁸ Cr Y, see ⁴⁸ Cr	4E+4 - -	5E+4 2E+4 2E+4	2E-5 1E-5 8E-6	6E-8 3E-8 3E-8	5E-4 - -	5E-3 - -
27	Cobalt-55	W, all compounds except those given for Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
27	Cobalt-56	W, see ⁵⁵ Co Y, see ⁵⁵ Co	5E+2 4E+2	3E+2 2E+2	1E-7 8E-8	4E-10 3E-10	6E-6 -	6E-5 -
27	Cobalt-57	W, see ⁵⁵ Co Y, see ⁵⁵ Co	8E+3 4E+3	3E+3 7E+2	1E-6 3E-7	4E-9 9E-10	6E-5 -	6E-4 -
27	Cobalt-58	W, see ⁵⁵ Co Y, see ⁵⁵ Co	2E+3 1E+3	1E+3 7E+2	5E-7 3E-7	2E-9 1E-9	2E-5 -	2E-4
27	Cobalt-58m	W, see ⁵⁵ Co	6E+4	9E+4	4E-5 3E-5	1E-7 9E-8	8E-4	8E-3

 I				Table 4B1 Occupational Values		Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	• • • • •
1			Ural	Inhala	ation			Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Table 4B3 Releases to Sewers Monthly Average Concentration (μCi/ml) 3E-5 - 2E-1 - 2E-1 - 2E-3 - 2E-4 - 7E-5 2E-4 - - 7E-6 - 3E-7
27	Cobalt-60	W, see ⁵⁵ Co Y, see ⁵⁵ Co	5E+2 2E+2	2E+2 3E+1	7E-8 1E-8	2E-10 5E-11	3E-6 -	3E-5 -
27	Cobalt-60m ²	W, see ⁵⁵ Co	1E+6 St wall	4E+6	2E-3	6E-6	-	-
		Y, see ⁵⁵ Co	(1E+6) -	- 3E+6	- 1E-3	- 4E-6	2E-2 -	2E-1 -
27	Cobalt-61 ²	W, see ⁵⁵ Co Y, see ⁵⁵ Co	2E+4 2E+4	6E+4 6E+4	3E-5 2E-5	9E-8 8E-8	3E-4 -	3E-3 -
27	Cobalt-62m ²	W, see ⁵⁵ Co	4E+4 St wall	2E+5	7E-5	2E-7	-	-
20	Copper-60 ²	Y, see ⁵⁵ Co	(5E+4) -	- 2E+5	- 6E-5	- 2E-7	7E-4 -	7E-3 -
23	Copper-00	those given for W and Y	3E+4 St wall	9E+4	4E-5	1E-7	-	-
		W sulfides balides	(3E+4)	-	-	-	4E-4	4E-3
		and nitrates Y, oxides and hydroxides	-	1E+5 1E+5	5E-5 4E-5	2E-7 1E-7	-	-
29	Copper-61	D, see ⁶⁰ Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ⁶⁰ Cu	-	4E+4	2E-5	6E-8	-	-
		Y, see ^{co} Cu	-	4E+4	1E-5	5E-8	-	-
29	Copper-64	D, see ⁶⁰ Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ⁶⁰ Cu	-	2E+4	1E-5	3E-8	-	-
		r, see Cu	-	20+4	92-0	32-0	-	-
29	Copper-67	D, see ⁶⁰ Cu	5E+3	8E+3	3E-6	1E-8	6E-5	6E-4
		W, see ⁶⁰ Cu Y see ⁶⁰ Cu	-	5E+3 5E+3	2E-6 2E-6	7E-9 6E-9	-	-
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 Bone surf	1E-8	-	2E-5	2E-4
			-	(4E+1)	-	5E-11	-	-
96	Curium-242	W, all compounds	3E+1 Bone surf	3E-1 Bone surf	1E-10	-	-	-
			(5E+1)	(3E-1)	-	4E-13	7E-7	7E-6
96	Curium-243	W, all compounds	1E+0 Bone surf	9E-3 Bone surf	4E-12	-	-	-
			(2E+0)	(2E-2)	-	2E-14	3E-8	3E-7

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					Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
			Col. 1 Oral Ingestion	Col. 2 Inhala	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
96	Curium-244	W, all compounds	1E+0 Bone surf	1E-2 Bone surf	5E-12	-	-	-
			(3E+0)	(2E-2)	-	3E-14	3E-8	3E-7
96	Curium-245	W, all compounds	7E-1 Bone surf (1E+0)	6E-3 Bone surf (1F-2)	3E-12	- 2F-14	- 2E-8	- 2F-7
96	Curium-246	W all compounds	(!=!0) 7E-1	(-= =) 6E-3	35-12			
30	Cunum-240		Bone surf (1E+0)	Bone surf (1E-2)	-	- 2E-14	- 2E-8	2E-7
96	Curium-247	W, all compounds	8E-1 Bone surf	6E-3 Bone surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
96	Curium-248	W, all compounds	2E-1 Bone surf (4E-1)	2E-3 Bone surf (3E-3)	7E-13	- 4F-15	- 5E-9	- 5E-8
96	Curium-249 ²	W, all compounds	5E+4	2E+4 Bono surf	7E-6	-	7E-4	7E-3
			-	(3E+4)	-	4E-8	-	-
96	Curium-250	W, all compounds	4E-2 Bone surf	3E-4 Bone surf	1E-13	-	-	-
			(6E-2)	(5E-4)	-	8E-16	9E-10	9E-9
66	Dysprosium-155	W, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
66	Dysprosium-157	W, all compounds	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
66	Dysprosium-159	W, all compounds	1E+4	2E+3	1E-6	3E-9	2E-4	2E-3
66	Dysprosium-165	W, all compounds	1E+4	5E+4	2E-5	6E-8	2E-4	2E-3
66	Dysprosium-166	W, all compounds	6E+2 LLI wall	7E+2	3E-7	1E-9	-	-
			(8E+2)	-	-	-	1E-5	1E-4
99	Einsteinium-250	W, all compounds	4E+4	5E+2 Bone surf (1E+3)	2E-7	- 2E-9	6E-4	6E-3
00	Finatainium 054		75.0	(12+3)	45 7	26-0	-	45.0
99	Einsteinium-251	vv, all compounds	/E+3 -	9E+2 Bone surf (1E+3)	4E-7 -	- 2E-9	1E-4 -	1E-3 -
99	Einsteinium-253	W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5

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I					Table 4B1 Occupational Values		Tabl Effl Concer	e 4B2 uent trations	Table 4B3 Releases to Sewers
1				Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
I	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
	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
	99	Einsteinium-254m	W, all compounds	3E+2 LLI wall	1E+1	4E-9	1E-11	-	-
				(3E+2)	-	-	-	4E-6	4E-5
	68	Erbium-161	W, all compounds	2E+4	6E+4	3E-5	9E-8	2E-4	2E-3
	68	Erbium-165	W, all compounds	6E+4	2E+5	8E-5	3E-7	9E-4	9E-3
	68	Erbium-169	W, all compounds	3E+3 LLI wall	3E+3	1E-6	4E-9	-	-
				(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 LLI wall	1E+3	6E-7	2E-9	-	-
	63	Europium 14E	W. all compounds	(E+3)	-	- 0E 7	-	20-5	26-4
	63	Europium 146	W, all compounds	2E+3	2E+3	0E-7	3E-9 2E 0	2E-0 1E E	2E-4
	63	Europium 147	W, all compounds	1E+3 2E+3	1E+3	3E-7	2E-9	12-3	12-4
	63	Europium 147	W, all compounds	3E+3	2E+3	15.7	2E-9	40-0	4E-4
	63	Europium-148	W, all compounds	10+3	4E+2	1E-7	3E-10	1E-0 0E-4	12-4
	63	Europium-149		12+4	3E+3	1E-6	40-9	20-4	2E-3
	63	(12.62 h)	w, all compounds	3E+3	8E+3	4E-0	IE-8	4E-0	4⊏-4
	63	Europium-150 (34.2 y)	W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
	63	Europium-152	W, all compounds	8E+2	2E+1	1E-8	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-154	W, all compounds	5E+2	2E+1	8E-9	3E-11	7E-6	7E-5
	63	Europium-155	W, all compounds	4E+3	9E+1 Bone surf	4E-8	-	5E-5	5E-4
				-	(1E+2)	-	2E-10	-	-

I				(Table 4B1 Occupational Values		Tabl Effl Concer	e 4B2 uent itrations	Table 4B3 Releases to Sewers
				Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
I	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (µCi/ml)
	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
	100	Fermium-252	W, all compounds	5E+2	1E+1	5E-9	2E-11	6E-6	6E-5
	100	Fermium-253	W, all compounds	1E+3	1E+1	4E-9	1E-11	1E-5	1E-4
	100	Fermium-254	W, all compounds	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
	100	Fermium-255	W, all compounds	5E+2	2E+1	9E-9	3E-11	7E-6	7E-5
	100	Fermium-257	W, all compounds	2E+1 Bone surf (4E+1)	2E-1 Bone surf (2E-1)	7E-11	- 3F-13	- 5E-7	- 5E-6
	9	Fluorine-18 ²	D fluorides of H Li	(4211)	(22 1)				
	0		Na, K, Rb, Cs, and Fr	5E+4 St wall	7E+4	3E-5	1E-7	- 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	-	-
	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
	64	Gadolinium-145 ²	D, all compounds except those given for W	5E+4 St wall	2E+5	6E-5	2E-7	-	-
			W, oxides, hydroxides, and fluorides	(5E+4) -	- 2E+5	- 7E-5	- 2E-7	6E-4 -	6E-3 -
	64	Gadolinium-146	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	1E+3 -	1E+2 3E+2	5E-8 1E-7	2E-10 4E-10	2E-5 -	2E-4
	64	Gadolinium-147	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	2E+3 -	4E+3 4E+3	2E-6 1E-6	6E-9 5E-9	3E-5 -	3E-4 -

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			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)	
64	Gadolinium-148	D, see ¹⁴⁵ Gd	1E+1 Bone surf	8E+3 Bone surf	3E-12	-	-	-	
		W, see ¹⁴⁵ Gd	(2E+1) -	(2E+2) 3E-2 Bone surf	- 1E-11	2E-14 -	3E-7 -	3E-6 -	
64	Gadolinium-149	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	- 3E+3 -	(6E-2) 2E+3 2E+3	- 9E-7 1E-6	8E-14 3E-9 3E-9	- 4E-5 -	- 4E-4	
64	Gadolinium-151	D, see ¹⁴⁵ Gd	6E+3	4E+2 Bone surf	2E-7	-	9E-5	9E-4	
		W, see ¹⁴⁵ Gd	-	(6E+2) 1E+3	- 5E-7	9E-10 2E-9	-	-	
64	Gadolinium-152	D, see ¹⁴⁵ Gd	2E+1 Bone surf (3E+1)	1E-2 Bone surf (2E-2)	4E-12	- 3E-14	- 4E-7	- 4E-6	
		W, see ¹⁴³ Gd	-	4E-2 Bone surf (8E-2)	2E-11 -	- 1E-13	-	-	
64	Gadolinium-153	D, see ¹⁴⁵ Gd	5E+3	1E+2 Bone surf	6E-8	-	6E-5	6E-4	
		W, see ¹⁴⁵ Gd	-	(2E+2) 6E+2	- 2E-7	3E-10 8E-10	-		
64	Gadolinium-159	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	3E+3 -	8E+3 6E+3	3E-6 2E-6	1E-8 8E-9	4E-5 -	4E-4 -	
31	Gallium-65 ²	D, all compounds except those given for W	5E+4 St wall	2E+5	7E-5	2E-7	-	-	
		W, oxides, hydroxides, carbides, halides, and	(6E+4)	-	-	-	9E-4	9E-3	
31	Gallium-66	nitrates	- 1E+3	2E+5	8E-5 1E-6	3E-7 5E-9	- 1E-5	- 1E-4	
21	Callium 67	W, see ⁶⁵ Ga	- 75+2	3E+3	1E-6	4E-9	-	-	
31		W, see ⁶⁵ Ga	-	1E+4 1E+4	4E-6	1E-8	1E-4 -	-	
31	Gaillum-68	D, see ⁵⁵ Ga W, see ⁶⁵ Ga	2E+4 -	4E+4 5E+4	2E-5 2E-5	6E-8 7E-8	2E-4 -	2E-3 -	
31	Gallium-70 ⁺	D, see "Ga	5E+4 St wall (7E+4)	2E+5 -	7E-5 -	2E-7 -	- 1E-3	- 1E-2	
		W, see ⁶⁵ Ga		2E+5	8E-5	3E-7	-	-	

I					Table 4B1 Occupational Values		Tabl Effl Concer	e 4B2 uent trations	Table 4B3 Releases to Sewers
				Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
	31	Gallium-72	D, see ⁶⁵ Ga W, see ⁶⁵ Ga	1E+3 -	4E+3 3E+3	1E-6 1E-6	5E-9 4E-9	2E-5 -	2E-4
	31	Gallium-73	D, see ⁶⁵ Ga W, see ⁶⁵ Ga	5E+3 -	2E+4 2E+4	6E-6 6E-6	2E-8 2E-8	7E-5 -	7E-4
	32	Germanium-66	D, all compounds except those given for W W, oxides, sulfides, and halides	2E+4	3E+4 2E+4	1E-5 8E-6	4E-8 3E-8	3E-4 -	3E-3 -
	32	Germanium-67 ²	D, see ⁶⁶ Ge	3E+4 St wall	9E+4	4E-5	1E-7	-	-
			W, see ⁶⁶ Ge	(4E+4) -	- 1E+5	- 4E-5	- 1E-7	6E-4 -	6E-3 -
	32	Germanium-68	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	5E+3 -	4E+3 1E+2	2E-6 4E-8	5E-9 1E-10	6E-5 -	6E-4 -
	32	Germanium-69	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	1E+4 -	2E+4 8E+3	6E-6 3E-6	2E-8 1E-8	2E-4	2E-3 -
	32	Germanium-71	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	5E+5 -	4E+5 4E+4	2E-4 2E-5	6E-7 6E-8	7E-3 -	7E-2 -
	32	Germanium-75 ²	D, see ⁶⁶ Ge	4E+4 St wall	8E+4	3E-5	1E-7	-	-
			W, see ⁶⁶ Ge	(7E+4) -	- 8E+4	- 4E-5	- 1E-7	9E-4 -	9E-3 -
	32	Germanium-77	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	9E+3 -	1E+4 6E+3	4E-6 2E-6	1E-8 8E-9	1E-4 -	1E-3 -
	32	Germanium-78 ²	D, see ⁶⁶ Ge	2E+4 St wall	2E+4	9E-6	3E-8	-	-
			W, see ⁶⁶ Ge	(2E+4) -	- 2E+4	- 9E-6	- 3E-8	3E-4 -	3E-3 -
	79	Gold-193	D, all compounds except those given for W and Y W, halides and nitrates Y, oxides and hydroxides	9E+3 - -	3E+4 2E+4 2E+4	1E-5 9E-6 8E-6	4E-8 3E-8 3E-8	1E-4 - -	1E-3 - -
	79	Gold-194	D, see ¹⁹³ Au W, see ¹⁹³ Au Y, see ¹⁹³ Au	3E+3 - -	8E+3 5E+3 5E+3	3E-6 2E-6 2E-6	1E-8 8E-9 7E-9	4E-5 - -	4E-4 - -
	79	Gold-195	D, see ¹⁹³ Au W, see ¹⁹³ Au Y, see ¹⁹³ Au	5E+3 - -	1E+4 1E+3 4E+2	5E-6 6E-7 2E-7	2E-8 2E-9 6E-10	7E-5 - -	7E-4 - -

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
			Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)	
79	Gold-198	D. see ¹⁹³ Au	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4	
		W, see ¹⁹³ Au Y, see ¹⁹³ Au	-	2E+3 2E+3	8E-7 7E-7	3E-9 2E-9	-	-	
79	Gold-198m	D, see ¹⁹³ Au W, see ¹⁹³ Au	1E+3 -	3E+3 1E+3	1E-6 5E-7	4E-9 2E-9	1E-5 -	1E-4	
		Y, see ¹⁹³ Au	-	1E+3	5E-7	2E-9	-	-	
79	Gold-199	D, see ¹⁹³ Au	3E+3 LLI wall	9E+3	4E-6	1E-8	-	-	
		W(and ¹⁹³ Au	(3E+3)	-	-	-	4E-5	4E-4	
		Y, see ¹⁹³ Au	-	4E+3 4E+3	2E-6	5E-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 Y, see ¹⁹³ Au	-	8E+4 7E+4	3E-5 3E-5	1E-7 1E-7	-	-	
79	Gold-200m	D, see ¹⁹³ Au	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4	
		W, see ¹⁹³ Au Y, see ¹⁹³ Au	-	3E+3 2E+4	1E-6 1E-6	4E-9 3E-9	-	-	
79	Gold-201 ²	D, see ¹⁹³ Au	7E+4 St wall	2E+5	9E-5	3E-7	-	-	
		193 .	(9E+4)	-			1E-3	1E-2	
		W, see ¹⁹³ Au Y, see ¹⁹³ Au	-	2E+5 2E+5	1E-4 9E-5	3E-7 3E-7	-	-	
72	Hafnium-170	D, all compounds except							
		those given for W W, oxides, hydroxides.	3E+3	6E+3	2E-6	8E-9	4E-5	4E-4	
		carbides, and nitrates	-	5E+3	2E-6	6E-9	-	-	
72	Hafnium-172	D, see ¹⁷⁰ Hf	1E+3	9E+0 Bone surf	4E-9	-	2E-5	2E-4	
		W coo ¹⁷⁰ Hf	-	(2E+1)	-	3E-11	-	-	
				Bone surf (6E+1)	-	- 8E-11	-	-	
72	Hafnium-173	D, see ¹⁷⁰ Hf W, see ¹⁷⁰ Hf	5E+3 -	1E+4 1E+4	5E-6 5E-6	2E-8 2E-8	7E-5 -	7E-4	
72	Hafnium-175	D, see ¹⁷⁰ Hf	3E+3	9E+2 Bone surf	4E-7	-	4E-5	4E-4	
		W. see ¹⁷⁰ Hf	-	(1E+3) 1E+3	- 5E-7	1E-9 2E-9	-	-	

				Table 4B1 Occupational Values			e 4B2 luent htrations	Table 4B3 Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
72	Hafnium-177m ²	D. see ¹⁷⁰ Hf	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		W, see ¹⁷⁰ Hf	-	9E+4	4E-5	1E-7	-	-
72	Hafnium-178m	D, see ¹⁷⁰ Hf	3E+2	1E+0 Bone surf	5E-10	-	3E-6	3E-5
		W, see ¹⁷⁰ Hf	-	5E+0 Bone surf	- 2E-9	3E-12 -	-	-
			-	(9E+0)	-	1E-11	-	-
72	Hafnium-179m	D, see ¹⁷⁰ Hf	1E+3	3E+2 Bone surf	1E-7	-	1E-5	1E-4
		W, see ¹⁷⁰ Hf	-	(6E+2) 6E+2	- 3E-7	8E-10	-	-
72	Hafnium-180m	D, see ¹⁷⁰ Hf W, see ¹⁷⁰ Hf	7E+3 -	2E+4 3E+4	9E-6 1E-5	3E-8 4E-8	1E-4 -	1E-3 -
72	Hafnium-181	D, see ¹⁷⁰ Hf	1E+3	2E+2 Bone surf	7E-8	-	2E-5	2E-4
		W, see ¹⁷⁰ Hf	:	(4E+2) 4E+2	- 2E-7	6E-10 6E-10	-	-
72	Hafnium-182	D, see ¹⁷⁰ Hf	2E+2 Bone surf	8E-1 Bone surf	3E-10	-	-	-
		W, see ¹⁷⁰ Hf	(4E+2) -	(2E+0) 3E+0 Bone surf	- 1E-9	2E-12 -	5E-6 -	5E-5 -
			-	(7E+0)	-	1E-11	-	-
72	Hafnium-182m ²	D, see ¹⁷⁰ Hf W, see ¹⁷⁰ Hf	4E+4 -	9E+4 1E+5	4E-5 6E-5	1E-7 2E-7	5E-4 -	5E-3 -
72	Hafnium-183 ²	D, see ¹⁷⁰ Hf W, see ¹⁷⁰ Hf	2E+4 -	5E+4 6E+4	2E-5 2E-5	6E-8 8E-8	3E-4 -	3E-3 -
72	Hafnium-184	D, see ¹⁷⁰ Hf W, see ¹⁷⁰ Hf	2E+3 -	8E+3 6E+3	3E-6 3E-6	1E-8 9E-9	3E-5 -	3E-4
67	Holmium-155 ²	W, all compounds	4E+4	2E+5	6E-5	2E-7	6E-4	6E-3
67	Holmium-157 ²	W, all compounds	3E+5	1E+6	6E-4	2E-6	4E-3	4E-2
67	Holmium-159 ²	W, all compounds	2E+5	1E+6	4E-4	1E-6	3E-3	3E-2
67	Holmium-161	W, all compounds	1E+5	4E+5	2E-4	6E-7	1E-3	1E-2

I					Table 4B1 Occupational Values	;	Tab Eff Concer	le 4B2 luent htrations	Table 4B3 Releases to Sewers
				Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
	67	Holmium-162 ²	W, all compounds	5E+5 St wall	2E+6	1E-3	3E-6	-	
				(8E+5)	-	-	-	1E-2	1E-1
	67	Holmium-162m ²	W, all compounds	5E+4	3E+5	1E-4	4E-7	7E-4	7E-3
	67	Holmium-164 ²	W, all compounds	2E+5 St wall	6E+5	3E-4	9E-7	-	-
				(2E+5)	-	-	-	3E-3	3E-2
	67	Holmium-164m ²	W, all compounds	1E+5	3E+5	1E-4	4E-7	1E-3	1E-2
	67	Holmium-166	W, all compounds	9E+2 LLI wall	2E+3	7E-7	2E-9	-	-
	67	Holmium-167	W, all compounds	(9E+2) 2E+4	- 6E+4	- 2E-5	- 8E-8	1E-5 2E-4	2E-3
	67	Holmium-166m	W, all compounds	6E+2	7E+0	3E-9	9E-12	9E-6	9E-5
	1	Hydrogen-3	Water, DAC includes skin absorption Gas (HT or T ₂) Submersion ¹	8E+4 Use above values	8E+4 as HT and T_2 oxidize in	2E-5 n air and in the body to	1E-7 HTO.	1E-3	1E-2
	49	Indium-109	D, all compounds except those given for W	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
			halides, and nitrates	-	6E+4	3E-5	9E-8	-	-
	49	Indium-110 (4.9 h)	D, see ¹⁰⁹ In W, see ¹⁰⁹ In	5E+3 -	2E+4 2E+4	7E-6 8E-6	2E-8 3E-8	7E-5 -	7E-4 -
	49	Indium-110 ² (69.1 min)	D, see ¹⁰⁹ In W, see ¹⁰⁹ In	2E+4 -	4E+4 6E+4	2E-5 2E-5	6E-8 8E-8	2E-4 -	2E-3 -
	49	Indium-111	D, see ¹⁰⁹ In W, see ¹⁰⁹ In	4E+3 -	6E+3 6E+3	3E-6 3E-6	9E-9 9E-9	6E-5 -	6E-4 -
	49	Indium-112 ²	D, see ¹⁰⁹ In W, see ¹⁰⁹ In	2E+5 -	6E+5 7E+5	3E-4 3E-4	9E-7 1E-6	2E-3 -	2E-2 -
	49	Indium-113m ²	D, see ¹⁰⁹ In W, see ¹⁰⁹ In	5E+4 -	1E+5 2E+5	6E-5 8E-5	2E-7 3E-7	7E-4 -	7E-3 -
	49	Indium-114m	D, see ¹⁰⁹ In	3E+2 LLI wall	6E+1	3E-8	9E-11	-	-
			W. see ¹⁰⁹ In	(4⊑+∠) -	- 1E+2	- 4E-8	- 1E-10	0-⊐C	0E-0 -

 I				Table 4B1 Occupational Values			le 4B2 luent ntrations	Table 4B3 Releases to Sewers
l			Col. 1	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	
Ì			Ingestion	Inhal	ation			Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
40	Indium 115	D. 000 ¹⁰⁹ 10	45.4	15.0	6E 10	2E 12	6E 7	55.6
49	maium-115	W, see ¹⁰⁹ In	-	5E+0	2E-9	8E-12	-	-
49	Indium-115m	D, see ¹⁰⁹ In W, see ¹⁰⁹ In	1E+4 -	4E+4 5E+4	2E-5 2E-5	6E-8 7E-8	2E-4 -	2E-3 -
49	Indium-116m ²	D, see ¹⁰⁹ In W, see ¹⁰⁹ In	2E+4	8E+4 1E+5	3E-5 5E-5	1E-7 2E-7	3E-4 -	3E-3 -
49	Indium-117 ²	D, see ¹⁰⁹ In W, see ¹⁰⁹ In	6E+4	2E+5 2E+5	7E-5 9E-5	2E-7 3E-7	8E-4 -	8E-3 -
49	Indium-117m ²	D, see ¹⁰⁹ In W, see ¹⁰⁹ In	1E+4 -	3E+4 4E+4	1E-5 2E-5	5E-8 6E-8	2E-4 -	2E-3 -
49	Indium-119m ²	D, see ¹⁰⁹ In	4E+4 St wall	1E+5	5E-5	2E-7	-	
		W, see ¹⁰⁹ In	(5E+4) -	- 1E+5	- 6E-5	- 2E-7	7E-4 -	7E-3 -
53	lodine-120 ²	D, all compounds	4E+3 Thyroid	9E+3 Thyroid	4E-6	-	-	
			(8E+3)	(1E+4)	-	2E-8	1E-4	1E-3
53	lodine-120m ²	D, all compounds	1E+4 Thyroid (1E+4)	2E+4	9E-6	3E-8	- 2E-4	- 2E-3
53	Iodine-121	D all compounds	(TE+4)	2E+4	8E-6	-	-	-
00			Thyroid (3E+4)	Thyroid (5E+4)	-	7E-8	4E-4	4E-3
53	lodine-123	D, all compounds	3E+3	6E+3	3E-6	-	-	-
			Thyroid (1E+4)	Thyroid (2E+4)	-	2E-8	1E-4	1E-3
53	lodine-124	D, all compounds	5E+1	8E+1	3E-8	-	-	-
			(2E+2)	(3E+2)	-	4E-10	2E-6	2E-5
53	lodine-125	D, all compounds	4E+1	6E+1 Thyroid	3E-8	-	-	-
			(1E+2)	(2E+2)	-	3E-10	2E-6	2E-5
53	lodine-126	D, all compounds	2E+1 Thyroid	4E+1 Thyroid	1E-8	-	-	-
			(7E+1)	(1E+2)	-	2E-10	1E-6	1E-5
53	Iodine-128 ²	D, all compounds	4E+4 St wall	1E+5	5E-5	2E-7	-	-
			(6E+4)	-	-	-	8E-4	8E-3

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly	
Atomic No.	Radionuclide	clide Class	ALI μCi)	ALI (μCi)	<u>ation</u> DAC (μCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Average Concentration (μCi/ml)	
53	lodine-129	D, all compounds	5E+0 Thyroid (2E+1)	9E+0 Thyroid (3E+1)	4E-9 -	- 4E-11	- 2E-7	- 2E-6	
53	lodine-130	D, all compounds	4E+2 Thyroid (1E+3)	7E+2 Thyroid (2E+3)	3E-7 -	- 3E-9	- 2E-5	- 2E-4	
53	lodine-131	D, all compounds	3E+1 Thyroid (9E+1)	5E+1 Thyroid (2E+2)	2E-8	- 2E-10	- 1E-6	- 1E-5	
53	lodine-132	D, all compounds	4E+3 Thyroid (9E+3)	8E+3 Thyroid (1E+4)	3E-6	- 2E-8	- 1F-4	- 1E-3	
53	lodine-132m ²	D, all compounds	4E+3 Thyroid (1E+4)	8E+3 Thyroid	4E-6	- 3E-8	- 1E-4	- 1E-3	
53	lodine-133	D, all compounds	1E+2 Thyroid	3E+2 Thyroid	- 1E-7	-	-	-	
53	lodine-134 ²	D, all compounds	(SE+2) 2E+4 Thyroid	(9E+2) 5E+4	- 2E-5	6E-8	-	-	
53	lodine-135	D, all compounds	(3E+4) 8E+2 Thyroid (2E+2)	- 2E+3 Thyroid	- 7E-7	- -	4E-4 -	4E-3 - 2E 4	
77	Iridium-182 ²	D, all compounds except those given for W and Y	(3E+3) 4E+4 St wall	(4E+3) 1E+5	- 6E-5	8E-9 2E-7	3E-5	3E-4 -	
		W, halides, nitrates, and metallic iridium Y, oxides and hydroxides	(4E+4) - -	- 2E+5 1E+5	- 6E-5 5E-5	- 2E-7 2E-7	6E-4 - -	6E-3 - -	
77	Iridium-184	D, see ¹⁸² Ir W, see ¹⁸² Ir Y, see ¹⁸² Ir	8E+3 - -	2E+4 3E+4 3E+4	1E-5 1E-5 1E-5	3E-8 5E-8 4E-8	1E-4 - -	1E-3 - -	
77	Iridium-185	D, see ¹⁸² Ir W, see ¹⁸² Ir Y, see ¹⁸² Ir	5E+3 - -	1E+4 1E+4 1E+4	5E-6 5E-6 4E-6	2E-8 2E-8 1E-8	7E-5 - -	7E-4 - -	
77	Iridium-186	D, see ¹⁸² Ir W, see ¹⁸² Ir Y, see ¹⁸² Ir	2E+3 - -	8E+3 6E+3 6E+3	3E-6 3E-6 2E-6	1E-8 9E-9 8E-9	3E-5 - -	3E-4 - -	

				Table 4B1 Occupational Values	;	Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
77	Iridium-187	D, see ¹⁸² lr W, see ¹⁸² lr	1E+4 -	3E+4 3E+4	1E-5 1E-5	5E-8 4E-8	1E-4 -	1E-3 -
77	Iridium-188	Y, see ¹⁸² Ir D, see ¹⁸² Ir W, see ¹⁸² Ir	- 2E+3 -	3E+4 5E+3 4E+3	1E-5 2E-6 1E-6	4E-8 6E-9 5E-9	- 3E-5 -	- 3E-4 -
77	Iridium-189	Y, see ¹⁸² Ir D, see ¹⁸² Ir	- 5E+3	3E+3 5E+3	1E-6 2E-6	5E-9 7E-9	-	-
		W, see ¹⁸² Ir Y. see ¹⁸² Ir	(5E+3) -	- 4E+3 4E+3	- 2E-6 1E-6	- 5E-9 5E-9	7E-5 - -	7E-4 - -
77	Iridium-190	D, see ¹⁸² lr W, see ¹⁸² lr	1E+3 -	9E+2 1E+3 95+2	4E-7 4E-7	1E-9 1E-9 1E 0	1E-5 -	1E-4 -
77	Iridium-190m ²	D, see ¹⁸² Ir W, see ¹⁸² Ir	- 2E+5 -	2E+5 2E+5 2E+5	4E-7 8E-5 9E-5	3E-7 3E-7	2E-3 -	- 2E-2 -
77	Iridium-192	D, see ¹⁸² lr W, see ¹⁸² lr	- 9E+2 -	2E+5 3E+2 4E+2	8E-5 1E-7 2E-7	4E-10 6E-10	- 1E-5 -	- 1E-4 -
77	Iridium-192m	Y, see ¹⁸² lr D, see ¹⁸² lr W, see ¹⁸² lr	- 3E+3 -	2E+2 9E+1 2E+2	9E-8 4E-8 9E-8	3E-10 1E-10 3E-10	- 4E-5 -	- 4E-4
77	Iridium-194	Y, see ¹⁸² lr D, see ¹⁸² lr	- 1E+3	2E+1 3E+3	6E-9 1E-6	2E-11 4E-9	- 1E-5	- 1E-4
77	Iridium-194m	W, see ¹⁰² Ir Y, see ¹⁸² Ir	- - 6E+2	2E+3 2E+3 9E+1	9E-7 8E-7 4E-8	3E-9 3E-9 1E-10	- - 9E-6	- - 9E-5
		W, see ¹⁸² Ir Y, see ¹⁸² Ir	-	2E+2 1E+2	7E-8 4E-8	2E-10 1E-10	-	-
77	Iridium-195	D, see ¹⁸² lr W, see ¹⁸² lr Y, see ¹⁸² lr	1E+4 - -	4E+4 5E+4 4E+4	2E-5 2E-5 2E-5	6E-8 7E-8 6E-8	2E-4 - -	2E-3 - -
77	Iridium-195m	D, see ¹⁸² Ir W, see ¹⁸² Ir Y, see ¹⁸² Ir	8E+3 -	2E+4 3E+4 2E+4	1E-5 1E-5 9E-6	3E-8 4E-8 3E-8	1E-4 - -	1E-3 - -

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
			Ingestion	Inha	lation			Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
26	Iron-52	D, all compounds except those given for W W, oxides, hydroxides,	9E+2	3E+3	1E-6	4E-9	1E-5	1E-4
		and halides	-	2E+3	1E-6	3E-9	-	-
26	Iron-55	D, see ⁵² Fe W, see ⁵² Fe	9E+3 -	2E+3 4E+3	8E-7 2E-6	3E-9 6E-9	1E-4 -	1E-3 -
26	Iron-59	D, see ⁵² Fe W, see ⁵² Fe	8E+2 -	3E+2 5E+2	1E-7 2E-7	5E-10 7E-10	1E-5 -	1E-4 -
26	Iron-60	D, see ⁵² Fe W, see ⁵² Fe	3E+1 -	6E+0 2E+1	3E-9 8E-9	9E-12 3E-11	4E-7 -	4E-6 -
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-85	Submersion ¹	-	-	1E-4	7E-7	-	-
36	Krypton-85m	Submersion ¹	-	-	2E-5	1E-7	-	-
36	Krypton-87 ²	Submersion ¹	-	-	5E-6	2E-8	-	-
36	Krypton-88	Submersion ¹	-	-	2E-6	9E-9	-	-
57	Lanthanum-131 ²	D, all compounds except those given for W W, oxides and hydroxides	5E+4	1E+5 2E+5	5E-5 7E-5	2E-7 2E-7	6E-4	6E-3
57	Lanthanum-132	D, see ¹³¹ La W, see ¹³¹ La	3E+3 -	1E+4 1E+4	4E-6 5E-6	1E-8 2E-8	4E-5 -	4E-4
57	Lanthanum-135	D, see ¹³¹ La W, see ¹³¹ La	4E+4 -	1E+5 9E+4	4E-5 4E-5	1E-7 1E-7	5E-4 -	5E-3 -
57	Lanthanum-137	D, see ¹³¹ La	1E+4	6E+1 Liver	3E-8	-	2E-4	2E-3
		W, see ¹³¹ La	-	(7E+1) 3E+2 Liver	- 1E-7	1E-10 -	-	-
			-	(3E+2)	-	4E-10	-	-

					Table 4B1 Occupational Values			e 4B2 luent htrations	Table 4B3 Releases to Sewers
1				Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
A N	tomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
:	57	Lanthanum-138	D, see ¹³¹ La W, see ¹³¹ La	9E+2	4E+0 1E+1	1E-9 6E-9	5E-12 2E-11	1E-5 -	1E-4 -
	57	Lanthanum-140	D, see ¹³¹ La W, see ¹³¹ La	6E+2	1E+3 1E+3	6E-7 5E-7	2E-9 2E-9	9E-6 -	9E-5 -
:	57	Lanthanum-141	D, see ¹³¹ La W, see ¹³¹ La	4E+3 -	9E+3 1E+4	4E-6 5E-6	1E-8 2E-8	5E-5 -	5E-4
:	57	Lanthanum-142 ²	D, see ¹³¹ La W, see ¹³¹ La	8E+3 -	2E+4 3E+4	9E-6 1E-5	3E-8 5E-8	1E-4 -	1E-3 -
4	57	Lanthanum-143 ²	D, see ¹³¹ La	4E+4 St wall	1E+5	4E-5	1E-7	-	-
			W, see ¹³¹ La	(4E+4) -	- 9E+4	- 4E-5	- 1E-7	5E-4 -	5E-3 -
	82	Lead-195m ²	D, all compounds	6E+4	2E+5	8E-5	3E-7	8E-4	8E-3
	82	Lead-198	D, all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
	82	Lead-199 ²	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
	82	Lead-200	D, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
	82	Lead-201	D, all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3
	82	Lead-202	D, all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5
	82	Lead-202m	D, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
	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
1	82	Lead-210	D, all compounds	6E1 Bone surf	2E1 Bone surf	1E-10	-	-	-
	00	Lood 211 ²		(1=+0)	(4=-1)	-	0E-13	1E-0 2E 4	15-7
	o∠ 00		D, all compounds	107+4	0E+2	35-7	92-10	∠⊏-4	2E-3
	82	Lead-212	ם, all compounds	8⊏+1 Bone surf (1E+2)	3E+1 -	ï⊑-8 -	5E-11 -	- 2E-6	- 2E-5
	82	Lead-214 ²	D, all compounds	9E+3	8E+2	3E-7	1E-9	1E-4	1E-3

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
71	Lutetium-169	W, all compounds except those given for Y	3E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		Y, oxides, hydroxides, and fluorides	-	4E+3	2E-6	6E-9	-	-
71	Lutetium-170	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	1E+3 -	2E+3 2E+3	9E-7 8E-7	3E-9 3E-9	2E-5 -	2E-4
71	Lutetium-171	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	2E+3 -	2E+3 2E+3	8E-7 8E-7	3E-9 3E-9	3E-5 -	3E-4 -
71	Lutetium-172	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	1E+3 -	1E+3 1E+3	5E-7 5E-7	2E-9 2E-9	1E-5 -	1E-4 -
71	Lutetium-173	W, see ¹⁶⁹ Lu	5E+3	3E+2 Bone surf	1E-7	-	7E-5	7E-4
		Y, see ¹⁶⁹ Lu	-	(5E+2) 3E+2	- 1E-7	4E-10	-	-
71	Lutetium-174	W, see ¹⁶⁹ Lu	5E+3	1E+2 Bone surf	5E-8	-	7E-5	7E-4
		Y, see ¹⁶⁹ Lu	-	(2E+2) 2E+2	- 6E-8	3E-10 2E-10	-	-
71	Lutetium-174m	W, see ¹⁶⁹ Lu	2E+3 LLI wall	2E+2 Bone surf	1E-7	-	-	-
		Y, see ¹⁶⁹ Lu	(3E+3) -	(3E+2) 2E+2	- 9E-8	5E-10 3E-10	4E-5 -	4E-4 -
71	Lutetium-176	W, see ¹⁶⁹ Lu	7E+2	5E+0 Bone surf	2E-9	-	1E-5	1E-4
		Y, see ¹⁶⁹ Lu	-	(1E+1) 8E+0	- 3E-9	2E-11 1E-11	:	-
71	Lutetium-176m	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	8E+3 -	3E+4 2E+4	1E-5 9E-6	3E-8 3E-8	1E-4 -	1E-3 -
71	Lutetium-177	W, see ¹⁶⁹ Lu	2E+3 LLI wall	2E+3	9E-7	3E-9	-	-
		Y, see ¹⁶⁹ Lu	(3E+3) -	- 2E+3	- 9E-7	- 3E-9	4E-5 -	4E-4 -
71	Lutetium-177m	W, see ¹⁶⁹ Lu	7E+2	1E+2 Bone surf	5E-8	-	1E-5	1E-4
		Y, see ¹⁶⁹ Lu	-	(1E+2) 8E+1	- 3E-8	2E-10 1E-10	-	-

I					Table 4B1 Occupational Values		Tabl Eff Concer	e 4B2 luent htrations	Table 4B3 Releases to Sewers
l				Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
l	Atomic No.	Radionuclide	Class	Ingestion ALI (μCi)	ALI (μCi)	tion DAC (μCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Average Concentration (µCi/ml)
	71	Lutetium-178 ²	W, see ¹⁶⁹ Lu	4E+4 St wall	1E+5	5E-5	2E-7	-	-
			Y, see ¹⁶⁹ Lu	(4E+4) -	- 1E+5	- 5E-5	- 2E-7	6E-4 -	6E-3 -
	71	Lutetium-178m ²	W, see ¹⁶⁹ Lu	5E+4 St. wall	2E+5	8E-5	3E-7	-	-
			Y, see ¹⁶⁹ Lu	(6E+4)	- 2E+5	- 7E-5	- 2E-7	8E-4 -	8E-3 -
	71	Lutetium-179	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	6E+3 -	2E+4 2E+4	8E-6 6E-6	3E-8 3E-8	9E-5 -	9E-4 -
	12	Magnesium-28	D, all compounds except those given for W W, oxides, hydroxides,	7E+2	2E+3	7E-7	2E-9	9E-6	9E-5
			nitrates	-	1E+3	5E-7	2E-9	-	-
	25	Manganese-51 ²	D, all compounds except those given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
			halides, and nitrates	-	6E+4	3E-5	8E-8	-	-
	25	Manganese-52	D, see ⁵¹ Mn W, see ⁵¹ Mn	7E+2 -	1E+3 9E+2	5E-7 4E-7	2E-9 1E-9	1E-5 -	1E-4 -
	25	Manganese-52m ²	D, see ⁵¹ Mn	3E+4 St wall	9E+4	4E-5	1E-7	-	-
			W, see ⁵¹ Mn	(4E+4) -	- 1E+5	- 4E-5	- 1E-7	5E-4 -	5E-3 -
	25	Manganese-53	D, see ⁵¹ Mn	5E+4	1E+4 Bone surf	5E-6	-	7E-4	7E-3
			W, see ⁵¹ Mn	-	(2E+4) 1E+4	- 5E-6	3E-8 2E-8	-	-
	25	Manganese-54	D, see ⁵¹ Mn W, see ⁵¹ Mn	2E+3 -	9E+2 8E+2	4E-7 3E-7	1E-9 1E-9	3E-5 -	3E-4 -
	25	Manganese-56	D, see ⁵¹ Mn W, see ⁵¹ Mn	5E+3 -	2E+4 2E+4	6E-6 9E-6	2E-8 3E-8	7E-5 -	7E-4 -
	101	Mendelevium-257	W, all compounds	7E+3	8E+1 Bone surf	4E-8	-	1E-4	1E-3
				-	(9E+1)	-	1E-10	-	-
	101	Mendelevium-258	W, all compounds	3E+1 Bone surf	2E-1 Bone surf	1E-10	-	-	-
				(5E+1)	(3E-1)	-	5E-13	6E-7	6E-6

I					Table 4B1 Occupational Values		Tabl Eff Concer	e 4B2 luent htrations	Table 4B3 Releases to Sewers
				Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
I	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
	80	Mercury-193	Vapor	-	3E+4	1E-5	4E-8	-	-
			Organic D D, see ^{193m} Hg W, see ^{193m} Hg	2E+4 2E+4 -	6E+4 4E+4 4E+4	3E-5 2E-5 2E-5	9E-8 6E-8 6E-8	3E-4 2E-4 -	3E-3 2E-3 -
	80	Mercury-193m	Vapor Organic D D, sulfates W. oxides, hydroxides,	- 4E+3 3E+3	8E+3 1E+4 9E+3	4E-6 5E-6 4E-6	1E-8 2E-8 1E-8	- 6E-5 4E-5	- 6E-4 4E-4
			halides, nitrates, and sulfides	-	8E+3	3E-6	1E-8	-	-
	80	Mercury-194	Vapor Organic D D, see ^{193m} Hg W, see ^{193m} Hg	- 2E+1 8E+2 -	3E+1 3E+1 4E+1 1E+2	1E-8 1E-8 2E-8 5E-8	4E-11 4E-11 6E-11 2E-10	- 2E-7 1E-5 -	- 2E-6 1E-4
	80	Mercury-195	Vapor Organic D D, see ^{193m} Hg W, see ^{193m} Hg	- 2E+4 1E+4	3E+4 5E+4 4E+4 3E+4	1E-5 2E-5 1E-5 1E-5	4E-8 6E-8 5E-8 5E-8	- 2E-4 2E-4 -	- 2E-3 2E-3
	80	Mercury-195m	Vapor Organic D D, see ^{193m} Hg W, see ^{193m} Hg	- 3E+3 2E+3 -	4E+3 6E+3 5E+3 4E+3	2E-6 3E-6 2E-6 2E-6	6E-9 8E-9 7E-9 5E-9	- 4E-5 3E-5 -	4E-4 3E-4
	80	Mercury-197	Vapor Organic D D, see ^{193m} Hg W, see ^{193m} Hg	- 7E+3 6E+3 -	8E+3 1E+4 1E+4 9E+3	4E-6 6E-6 5E-6 4E-6	1E-8 2E-8 2E-8 1E-8	- 9E-5 8E-5 -	- 9E-4 8E-4
	80	Mercury-197m	Vapor Organic D D, see ^{193m} Hg W, see ^{193m} Hg	- 4E+3 3E+3 -	5E+3 9E+3 7E+3 5E+3	2E-6 4E-6 3E-6 2E-6	7E-9 1E-8 1E-8 7E-9	- 5E-5 4E-5 -	- 5E-4 4E-4
	80	Mercury-199m ²	Vapor Organic D	- 6E+4	8E+4 2E+5	3E-5 7E-5	1E-7 2E-7	-	:
			D, see ^{193m} Hg W, see ^{193m} Hg	(1E+5) 6E+4 -	- 1E+5 2E+5	- 6E-5 7E-5	- 2E-7 2E-7	1E-3 8E-4 -	1E-2 8E-3 -
	80	Mercury-203	Vapor Organic D D, see ^{193m} Hg W, see ^{193m} Hg	- 5E+2 2E+3 -	8E+2 8E+2 1E+3 1E+3	4E-7 3E-7 5E-7 5E-7	1E-9 1E-9 2E-9 2E-9	- 7E-6 3E-5 -	- 7E-5 3E-4

I					Table 4B1 Occupational Values		Tabl Effl Concer	e 4B2 luent htrations	Table 4B3 Releases to Sewers
1				Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
ļ	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/mI)
	42	Molybdenum-101 ²	D, see ⁹⁰ Mo	4E+4 St wall	1E+5	6E-5	2E-7	-	-
			Y, see ⁹⁰ Mo	(5E+4) -	- 1E+5	- 6E-5	- 2E-7	7E-4 -	7E-3 -
	42	Molybdenum-90	D, all compounds except those given for Y Y, oxides, hydroxides,	4E+3	7E+3	3E-6	1E-8	3E-5	3E-4
			and MoS	2E+3	5E+3	2E-6	6E-9	-	-
	42	Molybdenum-93	D, see ⁹⁰ Mo Y, see ⁹⁰ Mo	4E+3 2E+4	5E+3 2E+2	2E-6 8E-8	8E-9 2E-10	5E-5 -	5E-4 -
	42	Molybdenum-93m	D, see ⁹⁰ Mo Y, see ⁹⁰ Mo	9E+3 4E+3	2E+4 1E+4	7E-6 6E-6	2E-8 2E-8	6E-5 -	6E-4
	42	Molybdenum-99	D, see ⁹⁰ Mo	2E+3 LLI wall	3E+3	1E-6	4E-9	-	-
			Y, see ⁹⁰ Mo	(1E+3) 1E+3	- 1E+3	- 6E-7	- 2E-9	2E-5 -	2E-4 -
	60	Neodymium-136 ²	W, all compounds except those given for Y X oxides	1E+4	6E+4	2E-5	8E-8	2E-4	2E-3
			carbides, and fluorides	-	5E+4	2E-5	8E-8	-	-
	60	Neodymium-138	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	2E+3 -	6E+3 5E+3	3E-6 2E-6	9E-9 7E-9	3E-5 -	3E-4 -
	60	Neodymium-139 ²	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	9E+4 -	3E+5 3E+5	1E-4 1E-4	5E-7 4E-7	1E-3 -	1E-2 -
	60	Neodymium-139m	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	5E+3 -	2E+4 1E+4	7E-6 6E-6	2E-8 2E-8	7E-5 -	7E-4 -
	60	Neodymium-141	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	2E+5 -	7E+5 6E+5	3E-4 3E-4	1E-6 9E-7	2E-3 -	2E-2
	60	Neodymium-147	W, see ¹³⁶ Nd	1E+3 LLI wall	9E+2	4E-7	1E-9	-	-
			Y, see ¹³⁶ Nd	(1E+3) -	- 8E+2	- 4E-7	- 1E-9	2E-5 -	2E-4
	60	Neodymium-149 ²	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	1E+4 -	3E+4 2E+4	1E-5 1E-5	4E-8 3E-8	1E-4 -	1E-3 -
	60	Neodymium-151 ²	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	7E+4 -	2E+5 2E+5	8E-5 8E-5	3E-7 3E-7	9E-4 -	9E-3 -

-	I		Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
1			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
1			Ingestion	Inhalat	ion			Average
Aton No.	nic Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
93	Neptunium-232 ²	W, all compounds	1E+5	2E+3 Bone surf	7E-7	-	2E-3	2E-2
	N		-	(3E+2)	-	0E-9	-	-
93	Neptunium-233	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 Bone surf	3E-7	-	-	-
			(2E+4)	(1E+3)	-	2E-9	3E-4	3E-3
93	Neptunium-236 (1.15E+5 v)	W, all compounds	3E+0 Bone surf	2E-2 Bone surf	9E-12	-	-	-
93	Neptunium-236	W, all compounds	(6E+0) 3E+3 Bone surf	(5E-2) 3E+1 Bone surf	- 1E-8	8E-14 -	9E-8 -	9E-7 -
	(22:0 :.)		(4E+3)	(7E+1)	-	1E-10	5E-5	5E-4
93	Neptunium-237	W, all compounds	5E-1 Bone surf	4E-3 Bone surf	2E-12	-	-	-
			(1E+0)	(1E-2)	-	1E-14	2E-8	2E-7
93	Neptunium-238	W, all compounds	1E+3	6E+1 Bone surf	3E-8	-	2E-5	2E-4
			-	(2E+2)	-	2E-10	-	-
93	Neptunium-239	W, all compounds	2E+3	2E+3	9E-7	3E-9	-	-
			(2E+3)	-	-	-	2E-5	2E-4
93	Neptunium-240 ²	W, all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
28	Nickel-56	D, all compounds except	15 0					a z (
		W, oxides, hydroxides,	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		and carbides Vapor	-	1E+3 1E+3	5E-7 5E-7	2E-9 2E-9	-	-
28	Nickel-57	D, see ⁵⁶ Ni	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
		W, see ³⁰ Ni Vapor	-	3E+3 6E+3	1E-6 3E-6	4E-9 9E-9	-	-
28	Nickel-59	D, see ⁵⁶ Ni	2E+4	4E+3	2E-6	5E-9	3E-4	3E-3
		W, see [∞] Ni Vapor	-	7E+3 2E+3	3E-6 8E-7	1E-8 3E-9	-	-
28	Nickel-63	D, see ⁵⁶ Ni	9E+3	2E+3	7E-7	2E-9	1E-4	1E-3
		W, see ^{se} Ni Vapor	-	3E+3 8E+2	1E-6 3E-7	4E-9 1E-9	-	-

				Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations	
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
Atomic No.	Radionuclide	onuclide Class	Ingestion ALI (μCi)	ALI (μCi)	llation DAC (μCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Average Concentration (µCi/ml)
28	Nickel-65	D, see ⁵⁶ Ni W, see ⁵⁶ Ni Vapor	8E+3 - -	2E+4 3E+4 2E+4	1E-5 1E-5 7E-6	3E-8 4E-8 2E-8	1E-4 - -	1E-3 - -
28	Nickel-66	D, see ⁵⁶ Ni	4E+2 LLI wall	2E+3	7E-7	2E-9	-	-
		W, see ⁵⁶ Ni Vapor	(5E+2) - -	- 6E+2 3E+3	- 3E-7 1E-6	- 9E-10 4E-9	6E-6 - -	6E-5 - -
41	Niobium-88 ²	W, all compounds except those given for Y	5E+4 St wall	2E+5	9E-5	3E-7	-	-
		Y, oxides and hydroxides	(7E+4) -	- 2E+5	- 9E-5	- 3E-7	1E-3 -	1E-2 -
41	Niobium-89	W, see ⁸⁸ Nb	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
	(12211111)	Y, see ⁸⁸ Nb	-	2E+4	6E-6	2E-8	-	-
41	Niobium-89 ²	W, see ⁸⁸ Nb	1E+4	4E+4	2E-5	6E-8	1E-4	1E-3
	(00 1111)	Y, see ⁸⁸ Nb	-	4E+4	2E-5	5E-8	-	-
41	Niobium-90	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	1E+3 -	3E+3 2E+3	1E-6 1E-6	4E-9 3E-9	1E-5 -	1E-4 -
41	Niobium-93m	W, see ⁸⁸ Nb	9E+3 LLI wall	2E+3	8E-7	3E-9	-	-
		Y, see ⁸⁸ Nb	(1E+4) -	- 2E+2	- 7E-8	- 2E-10	2E-4 -	2E-3 -
41	Niobium-94	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	9E+2 -	2E+2 2E+1	8E-8 6E-9	3E-10 2E-11	1E-5 -	1E-4 -
41	Niobium-95	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	2E+3	1E+3 1E+3	5E-7 5E-7	2E-9 2E-9	3E-5 -	3E-4
41	Niobium-95m	W, see ⁸⁸ Nb	2E+3 LLI wall	3E+3	1E-6	4E-9	-	-
		Y, see ⁸⁸ Nb	(2E+3)	- 2E+3	- 9E-7	- 3E-9	3E-5 -	3E-4 -
41	Niobium-96	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	1E+3 -	3E+3 2E+3	1E-6 1E-6	4E-9 3E-9	2E-5 -	2E-4
41	Niobium-97 ²	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	2E+4	8E+4 7E+4	3E-5 3E-5	1E-7 1E-7	3E-4 -	3E-3 -
41	Niobium-98 ²	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	1E+4	5E+4 5E+4	2E-5 2E-5	8E-8 7E-8	2E-4	2E-3

I					Table 4B1 Occupational Values	i	Tab Eff Conce	le 4B2 luent ntrations	Table 4B3 Releases to Sewers	
	Atomic No.	Radionuclide	Class	Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inha (μCi)	Col. 3 Col. 1 Ilation DAC (µCi/ml)	<mark>Col. 1</mark> Air (μCi/ml)	Col. 2 Water (µCi/ml)	Monthly Average Concentration (µCi/ml)	
	7	Nitrogen-13 ²	Submersion ¹	-	-	4E-6	2E-8	-	-	Comment [JJ2]: Nitrogen-13 added for
	76	Osmium-180 ²	D, all compounds except those given for W and Y W, halides and nitrates Y, oxides and hydroxides	1E+5 - -	4E+5 5E+5 5E+5	2E-4 2E-4 2E-4	5E-7 7E-7 6E-7	1E-3 - -	1E-2 - -	consistency with Appendix B of 10 CFR 20. RATS = 2007-3
	76	Osmium-181 ²	D, see ¹⁸⁰ Os W, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os	1E+4 - -	4E+4 5E+4 4E+4	2E-5 2E-5 2E-5	6E-8 6E-8 6E-8	2E-4 - -	2E-3 - -	
	76	Osmium-182	D, see ¹⁸⁰ Os W, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os	2E+3 - -	6E+3 4E+3 4E+3	2E-6 2E-6 2E-6	8E-9 6E-9 6E-9	3E-5 - -	3E-4 - -	
	76	Osmium-185	D, see ¹⁸⁰ Os W, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os	2E+3 - -	5E+2 8E+2 8E+2	2E-7 3E-7 3E-7	7E-10 1E-9 1E-9	3E-5 - -	3E-4 - -	
	76	Osmium-189m	D, see ¹⁸⁰ Os W, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os	8E+4 - -	2E+5 2E+5 2E+5	1E-4 9E-5 7E-5	3E-7 3E-7 2E-7	1E-3 - -	1E-2 - -	
	76	Osmium-191	D, see ¹⁸⁰ Os W, see ¹⁸⁰ Os	2E+3 LLI wall (3E+3) -	2E+3 - 2E+3	9E-7 - 7E-7	3E-9 - 2E-9	- 3E-5 -	- 3E-4 -	
	76	Osmium-191m	P, see ¹⁸⁰ Os W, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os	- 1E+4 - -	3E+4 2E+4 2E+4 2E+4	6E-7 1E-5 8E-6 7E-6	2E-9 4E-8 3E-8 2E-8	- 2E-4 -	- 2E-3 -	
	76	Osmium-193	D, see ¹⁸⁰ Os W, see ¹⁸⁰ Os	2E+3 LLI wall (2E+3)	5E+3 - 3E+3	2E-6 - 1 <u>E</u> -6	6E-9 - 4E-9	- 2E-5 -	- 2E-4	
	76	Osmium-194	Y, see ¹⁸⁰ Os	- 4E+2 LLI wall	3E+3 4E+1	1E-6 2E-8	4E-9 6E-11	- -	-	
			W, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os	(UL+2) - -	6E+1 8E+0	2E-8 3E-9	8E-11 1E-11	-	-	
	8	Oxygen-15 ²	Submersion ¹	-	-	4E-6	2E-8	-	-	Comment [JJ3]: Oxygen-15 added for
	46	Palladium-100	D, all compounds except those given for W and Y W, nitrates Y, oxides and hydroxides	1E+3 - -	1E+3 1E+3 1E+3	6E-7 5E-7 6E-7	2E-9 2E-9 2E-9	2E-5 - -	2E-4 - -	consistency with Appendix B or 10 CFR 20. RATS = 2007-3 Compatibility = A
	46	Palladium-101	D, see ¹⁰⁰ Pd W, see ¹⁰⁰ Pd Y, see ¹⁰⁰ Pd	1E+4 - -	3E+4 3E+4 3E+4	1E-5 1E-5 1E-5	5E-8 5E-8 4E-8	2E-4 - -	2E-3 - -	

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
1			Col. 1	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	·
1			Oral	Inhal	ation			Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
46	Palladium-103	D, see ¹⁰⁰ Pd	6E+3 LLI wall (7E+3)	6E+3	3E-6	9E-9	- 1F-4	- 1F-3
		W, see ¹⁰⁰ Pd	-	4E+3	2E-6	6E-9	-	-
		Y, see ¹⁰⁰ Pd	-	4E+3	1E-6	5E-9	-	-
46	Palladium-107	D, see ¹⁰⁰ Pd	3E+4 LLI wall	2E+4 Kidnevs	9E-6	-	-	-
		100	(4E+4)	(2E+4)	-	3E-8	5E-4	5E-3
		W, see ¹⁰⁰ Pd	-	7E+3	3E-6 2E-7	1E-8 6E-10	-	-
		1, 500 1 0		4212	22 /	OL 10		
46	Palladium-109	D, see ¹⁰⁰ Pd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		VV, see Pd Y see ¹⁰⁰ Pd	-	5E+3 5E+3	2E-6 2E-6	8E-9 6F-9	-	-
15	Phosphorus-32	D, all compounds except phosphates given for W W, phosphates of Zn ²⁺ , S ³⁺ Mo ²⁺ Fe ³⁺ Bi ³⁺	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
		and lanthanides	-	4E+2	2E-7	5E-10	-	-
15	Phosphorus-33	D, see ³² P W, see ³² P	6E+3 -	8E+3 3E+3	4E-6 1E-6	1E-8 4E-9	8E-5 -	8E-4 -
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-193	D, all compounds	4E+4	2E+4	1E-5	3E-8	-	-
			LLI wall (5E+4)	-	-	-	6E-4	6E-3
78	Platinum-193m	D, all compounds	3E+3	6E+3	3E-6	8E-9	-	-
			LLI wall (3E+4)	-	-	-	4E-5	4E-4
78	Platinum-195m	D all compounds	2E+3	4E+3	2E-6	6E-9	_	
		2, al compoundo	LLI wall (2E+3)	-	-	-	3E-5	3E-4
78	Platinum-197	D, all compounds	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
78	Platinum-197m ²	D, all compounds	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
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

				Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations	
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
94	Plutonium-234	W, all compounds except PuO Y, PuO	8E+3 -	2E+2 2E+2	9E-8 8E-8	3E-10 3E-10	1E-4 -	1E-3 -
94	Plutonium-235 ²	W, see ²³⁴ Pu Y, see ²³⁴ Pu	9E+5 -	3E+6 3E+6	1E-3 1E-3	4E-6 3E-6	1E-2 -	1E-1 -
94	Plutonium-236	W, see ²³⁴ Pu	2E+0 Bone surf	2E-2 Bone surf	8E-12	-	-	-
		Y, see ²³⁴ Pu	(4E+0) -	(4E-2) 4E-2	- 2E-11	5E-14 6E-14	6E-8 -	6E-7 -
94	Plutonium-237	W, see ²³⁴ Pu Y, see ²³⁴ Pu	1E+4 -	3E+3 3E+3	1E-6 1E-6	5E-9 4E-9	2E-4 -	2E-3
94	Plutonium-238	W, see ²³⁴ Pu	9E-1 Bone surf	7E-3 Bone surf	3E-12	-	-	-
		Y, see ²³⁴ Pu	(2E+0) -	(1E-2) 2E-2	- 8E-12	2E-14 2E-14	2E-8 -	2E-7 -
94	Plutonium-239	W, see ²³⁴ Pu	8E-1 Bone surf	6E-3 Bone surf	3E-12	-	-	-
		Y, see ²³⁴ Pu	(1E+0) - -	(1E-2) 2E-2 Bone surf (2E-2)	- 7E-12 -	2E-14 - 2E-14	2E-8 - -	2E-7 - -
94	Plutonium-240	W, see ²³⁴ Pu	8E-1 Bone surf	6E-3 Bone surf	3E-12	-	-	-
		Y, see ²³⁴ Pu	(1E+0) -	(1E-2) 2E-2 Bone surf	- 7E-12	2E-14 -	2E-8 -	2E-7 -
		224	-	(2E-2)	-	2E-14	-	-
94	Plutonium-241	W, see ²³ *Pu	4E+1 Bone surf (7E+1)	3E-1 Bone surf (6E-1)	1E-10	- 8E-13	- 1E-6	- 1E-5
		Y, see ²³⁴ Pu	-	8E-1 Bone surf	3E-10	-	-	-
94	Plutonium-242	W, see ²³⁴ Pu	- 8E-1	(TE+0) 7E-3	- 3E-12	-	-	-
		Y, see ²³⁴ Pu	Bone surf (1E+0) -	Bone surf (1E-2) 2E-2 Bone surf (2E-2)	- 7E-12 -	2E-14 - 2E-14	2E-8 -	2E-7 -
94	Plutonium-243	W, see ²³⁴ Pu Y, see ²³⁴ Pu	2E+4	4E+4 4E+4	2E-5 2E-5	5E-8 5E-8	2E-4	2E-3

ı —			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
94	Plutonium-244	W, see ²³⁴ Pu	8E-1 Bone surf	7E-3 Bone surf	3E-12	-	-	-
		Y, see ²³⁴ Pu	(2E+0)	(1E-2) 2E-2 Bone surf	- 7E-12	2E-14 -	2E-8 -	2E-7
			-	(2E-2)	-	2E-14	-	-
94	Plutonium-245	W, see ²³⁴ Pu Y, see ²³⁴ Pu	2E+3 -	5E+3 4E+3	2E-6 2E-6	6E-9 6E-9	3E-5 -	3E-4 -
94	Plutonium-246	W, see ²³⁴ Pu	4E+2 LLI wall	3E+2	1E-7	4E-10	-	-
		Y, see ²³⁴ Pu	(4E+2) -	- 3E+2	- 1E-7	- 4E-10	6E-6 -	6E-5 -
84	Polonium-203 ²	D, all compounds except those given for W W oxides bydrovides	3E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		and nitrates	-	9E+4	4E-5	1E-7	-	-
84	Polonium-205 ²	D, see ²⁰³ Po W, see ²⁰³ Po	2E+4 -	4E+4 7E+4	2E-5 3E-5	5E-8 1E-7	3E-4 -	3E-3 -
84	Polonium-207	D, see ²⁰³ Po W, see ²⁰³ Po	8E+3 -	3E+4 3E+4	1E-5 1E-5	3E-8 4E-8	1E-4 -	1E-3 -
84	Polonium-210	D, see ²⁰³ Po W, see ²⁰³ Po	3E+0 -	6E-1 6E-1	3E-10 3E-10	9E-13 9E-13	4E-8 -	4E-7 -
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	-	-
			(4E+4)	-	-	-	5E-4	5E-3
19	Potassium-45 ²	D, all compounds	3E+4 St wall	1E+5	5E-5	2E-7	-	
	2		(5E+4)	-	-	-	/ヒ-4	/E-3
59	Praseodymium-136 ²	W, all compounds except those given for Y	5E+4 St wall	2E+5	1E-4	3E-7	-	-
		Y, oxides, hydroxides,	(7E+4)	- 2E+5	- 9E-5	- 3E-7	1E-3	1E-2

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	- Monthly	
			Ingestion	Inhala	ation			Average	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)	
59	Praseodymium-137 ²	W, see ¹³⁶ Pr	4E+4	2E+5	6E-5	2E-7	5E-4	5E-3	
59	Praseodymium-138m	Y, see ¹³⁶ Pr W, see ¹³⁶ Pr	- 1E+4	1E+5 5E+4	6E-5 2E-5	2E-7 8E-8	- 1E-4	- 1E-3	
		Y, see ¹³⁵ Pr	-	4E+4	2E-5	6E-8	-	-	
59	Praseodymium-139	W, see ¹³⁶ Pr Y, see ¹³⁶ Pr	4E+4 -	1E+5 1E+5	5E-5 5E-5	2E-7 2E-7	6E-4 -	6E-3 -	
59	Praseodymium-142	W, see ¹³⁶ Pr Y, see ¹³⁶ Pr	1E+3 -	2E+3 2E+3	9E-7 8E-7	3E-9 3E-9	1E-5 -	1E-4 -	
59	Praseodymium-142m ²	W, see ¹³⁶ Pr Y, see ¹³⁶ Pr	8E+4 -	2E+5 1E+5	7E-5 6E-5	2E-7 2E-7	1E-3 -	1E-2 -	
59	Praseodymium-143	W, see ¹³⁶ Pr	9E+2 LLI wall	8E+2	3E-7	1E-9	-	-	
		Y, see ¹³⁶ Pr	(1E+3) -	- 7E+2	- 3E-7	- 9E-10	2E-5 -	2E-4 -	
59	Praseodymium-144 ²	W, see ¹³⁶ Pr	3E+4 St wall	1E+5	5E-5	2E-7	-	-	
		Y, see ¹³⁶ Pr	(4E+4) -	- 1E+5	- 5E-5	- 2E-7	6E-4 -	6E-3 -	
59	Praseodymium-145	W, see ¹³⁶ Pr Y, see ¹³⁶ Pr	3E+3 -	9E+3 8E+3	4E-6 3E-6	1E-8 1E-8	4E-5 -	4E-4	
59	Praseodymium-147 ²	W, see ¹³⁶ Pr	5E+4 St wall	2E+5	8E-5	3E-7	-		
		Y, see ¹³⁶ Pr	(8E+4) -	- 2E+5	- 8E-5	- 3E-7	1E-3 -	1E-2 -	
61	Promethium-141 ²	W, all compounds except	FF . 4	05.5	0F F	05.7			
		those given for Y	5E+4 St wall (6E+4)	2E+5 -	8E-5 -	3E-7 -	- 8E-4	- 8E-3	
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	7E-5	2E-7	-	-	
61	Promethium-143	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	5E+3 -	6E+2 7E+2	2E-7 3E-7	8E-10 1E-9	7E-5 -	7E-4	
61	Promethium-144	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	1E+3 -	1E+2 1E+2	5E-8 5E-8	2E-10 2E-10	2E-5	2E-4	
61	Promethium-145	W, see ¹⁴¹ Pm	1E+4	2E+2 Bone surf	7E-8	-	1E-4	1E-3	
		Y, see ¹⁴¹ Pm	-	(2E+2) 2E+2	- 8E-8	3E-10 3E-10	-	-	
			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
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	c Radionuclide	Class	Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average	
Atomic No.			ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)	
61	Promethium-146	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	2E+3 -	5E+1 4E+1	2E-8 2E-8	7E-11 6E-11	2E-5	2E-4	
61	Promethium-147	W, see ¹⁴¹ Pm	4E+3 LLI wall	1E+2 Bone surf	5E-8	-	-	-	
		Y, see ¹⁴¹ Pm	(5E+3)	(2E+2) 1E+2	- 6E-8	3E-10 2E-10	7E-5 -	7E-4 -	
61	Promethium-148	W, see ¹⁴¹ Pm	4E+2 LLI wall	5E+2	2E-7	8E-10	-	-	
		Y, see ¹⁴¹ Pm	(5E+2) -	- 5E+2	- 2E-7	- 7E-10	7E-6 -	7E-5 -	
61	Promethium-148m	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	7E+2 -	3E+2 3E+2	1E-7 1E-7	4E-10 5E-10	1E-5 -	1E-4 -	
61	Promethium-149	W, see ¹⁴¹ Pm	1E+3 LLI wall	2E+3	8E-7	3E-9	-	-	
		Y, see ¹⁴¹ Pm	(1E+3) -	- 2E+3	- 8E-7	- 2E-9	2E-5 -	2E-4 -	
61	Promethium-150	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	5E+3 -	2E+4 2E+4	8E-6 7E-6	3E-8 2E-8	7E-5 -	7E-4	
61	Promethium-151	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	2E+3 -	4E+3 3E+3	1E-6 1E-6	5E-9 4E-9	2E-5 -	2E-4	
91	Protactinium-227 ²	W, all compounds except those given for Y Y, oxides and hydroxides	4E+3	1E+2 1E+2	5E-8 4E-8	2E-10 1E-10	5E-5 -	5E-4	
91	Protactinium-228	W, see ²²⁷ Pa	1E+3	1E+1 Bone surf	5E-9	-	2E-5	2E-4	
		Y, see ²²⁷ Pa	-	(2E+1) 1E+1	- 5E-9	3E-11 2E-11	:	-	
91	Protactinium-230	W, see ²²⁷ Pa	6E+2 Bone surf	5E+0	2E-9	7E-12	-	-	
		Y, see ²²⁷ Pa	(9E+2) -	- 4E+0	- 1E-9	- 5E-12	1E-5 -	1E-4 -	
91	Protactinium-231	W, see ²²⁷ Pa	2E-1 Bone surf	2E-3 Bone surf	6E-13	-	-	-	
		Y, see ²²⁷ Pa	(5E-1) -	(4E-3) 4E-3 Bone surf	- 2E-12	6E-15 -	6E-9 -	6E-8 -	
			-	(6E-3)	-	8E-15	-	-	

				Table 4B1 Occupational Values			e 4B2 luent ntrations	Table 4B3 Releases to Sewers	
			Col. 1	Col. 2	Col. 3Col. 1	Col. 1 Col. 2			
			Oral	Inhala	tion			Monthly Average	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)	
91	Protactinium-232	W, see ²²⁷ Pa	1E+3	2E+1 Bopo surf	9E-9	-	2E-5	2E-4	
		Y, see ²²⁷ Pa		(6E+1) 6E+1 Bone surf (7E+1)	- 2E-8 -	8E-11 - 1E-10	-	-	
91	Protactinium-233	W, see ²²⁷ Pa	1E+3	7E+2	3E-7	1E-9	-	-	
		Y, see ²²⁷ Pa	(2E+3) -	- 6E+2	- 2E-7	- 8E-10	2E-5 -	2E-4 -	
91	Protactinium-234	W, see ²²⁷ Pa Y, see ²²⁷ Pa	2E+3 -	8E+3 7E+3	3E-6 3E-6	1E-8 9E-9	3E-5 -	3E-4	
88	Radium-223	W, all compounds	5E+0 Bone surf	7E-1	3E-10	9E-13	-	-	
			(9E+0)	-	-	-	1E-7	1E-6	
88	Radium-224	W, all compounds	8E+0 Bone surf (2E+1)	2E+0	7E-10	2E-12	- 2E-7	- 2E-6	
88	Radium-225	W, all compounds	8E+0 Bone surf	7E-1	3E-10	9E-13	-	-	
			(2E+1)	-	-	-	2E-7	2E-6	
88	Radium-226	W, all compounds	2E+0 Bone surf	6E-1	3E-10	9E-13	-	-	
			(5E+0)	-	-	-	6E-8	6E-7	
88	Radium-227 ²	W, all compounds	2E+4 Bone surf	1E+4 Bone surf	6E-6	-	-	-	
			(2E+4)	(2E+4)	-	3E-8	3E-4	3E-3	
88	Radium-228	W, all compounds	2E+0 Bone surf	1E+0	5E-10	2E-12	-	-	
			(4E+0)	-	-	-	6E-8	6E-7	
86	Radon-220	With daughters removed With daughters present	-	2E+4 2E+1 (or 12 working level months)	7E-6 9E-9 (or 1.0 working level)	2E-8 3E-11	-	-	
86	Radon-222	With daughters removed With daughters present	-	1E+4 1E+2 (or 4 working level months)	4E-6 3E-8 (or 0.33 working level)	1E-8 1E-10	-	:	

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				Table 4B1 Occupational Values		Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
			Col. 1	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2		
			Oral	Inha	lation			Monthly Average	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)	
75	Rhenium-177 ²	D, all compounds except those given for W	9E+4 St wall	3E+5	1E-4	4E-7	-	-	
		W oxidos hudroxidos	(1E+5)	-	-	-	2E-3	2E-2	
		and nitrates	-	4E+5	1E-4	5E-7	-	-	
75	Rhenium-178 ²	D, see ¹⁷⁷ Re	7E+4 St wall	3E+5	1E-4	4E-7	-	-	
		W, see ¹⁷⁷ Re	(1E+5) -	- 3E+5	- 1E-4	- 4E-7	1E-3 -	1E-2 -	
75	Rhenium-181	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	5E+3 -	9E+3 9E+3	4E-6 4E-6	1E-8 1E-8	7E-5 -	7E-4	
75	Rhenium-182 (12.7 h)	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	7E+3 -	1E+4 2E+4	5E-6 6E-6	2E-8 2E-8	9E-5 -	9E-4 -	
75	Rhenium-182 (64.0 h)	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	1E+3 -	2E+3 2E+3	1E-6 9E-7	3E-9 3E-9	2E-5 -	2E-4 -	
75	Rhenium-184	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	2E+3 -	4E+3 1E+3	1E-6 6E-7	5E-9 2E-9	3E-5 -	3E-4 -	
75	Rhenium-184m	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	2E+3 -	3E+3 4E+2	1E-6 2E-7	4E-9 6E-10	3E-5 -	3E-4	
75	Rhenium-186	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	2E+3 -	3E+3 2E+3	1E-6 7E-7	4E-9 2E-9	3E-5 -	3E-4	
75	Rhenium-186m	D, see ¹⁷⁷ Re	1E+3 St wall	2E+3 St wall	7E-7	-	-	-	
		W, see ¹⁷⁷ Re	(2E+3)	(2E+3) 2E+2	- 6E-8	3E-9 2E-10	2E-5 -	2E-4	
75	Rhenium-187	D, see ¹⁷⁷ Re	6E+5 St wall	8E+5	4E-4	-	8E-3	8E-2	
		W, see ¹⁷⁷ Re	-	(9E+5) 1E+5	- 4E-5	1E-6 1E-7	-	-	
75	Rhenium-188	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	2E+3 -	3E+3 3E+3	1E-6 1E-6	4E-9 4E-9	2E-5	2E-4	
75	Rhenium-188m ²	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	8E+4	1E+5 1E+5	6E-5 6E-5	2E-7 2E-7	1E-3 -	1E-2	
75	Rhenium-189	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	3E+3 -	5E+3 4E+3	2E-6 2E-6	7E-9 6E-9	4E-5 -	4E-4 -	
45	Rhodium-100	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	2E+3 -	5E+3 4E+3 4F+3	2E-6 2E-6 2E-6	7E-9 6E-9 5E-9	2E-5 - -	2E-4 -	

I				Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
1				Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
	45	Rhodium-101	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	2E+3 - -	5E+2 8E+2 2E+2	2E-7 3E-7 6E-8	7E-10 1E-9 2E-10	3E-5 - -	3E-4 - -
	45	Rhodium-101m	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	6E+3 - -	1E+4 8E+3 8E+3	5E-6 4E-6 3E-6	2E-8 1E-8 1E-8	8E-5 - -	8E-4 - -
	45	Rhodium-102	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	6E+2 - -	9E+1 2E+2 6E+1	4E-8 7E-8 2E-8	1E-10 2E-10 8E-11	8E-6 - -	8E-5 - -
	45	Rhodium-102m	D, see ^{99m} Rh	1E+3 LLI wall (1E+3)	5E+2 -	2E-7 -	7E-10 -	- 2E-5	- 2E-4
			W, see ^{99m} Rh Y, see ^{99m} Rh	-	4E+2 1E+2	2E-7 5E-8	5E-10 2E-10	-	-
	45	Rhodium-103m ²	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	4E+5 - -	1E+6 1E+6 1E+6	5E-4 5E-4 5E-4	2E-6 2E-6 2E-6	6E-3 - -	6E-2 - -
	45	Rhodium-105	D, see ^{99m} Rh	4E+3 LLI wall	1E+4	5E-6	2E-8	-	-
			W, see ^{99m} Rh Y, see ^{99m} Rh	(4E+3) - -	- 6E+3 6E+3	- 3E-6 2E-6	- 9E-9 8E-9	0E-0 - -	5E-4 - -
	45	Rhodium-106m	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	8E+3 - -	3E+4 4E+4 4E+4	1E-5 2E-5 1E-5	4E-8 5E-8 5E-8	1E-4 - -	1E-3 - -
	45	Rhodium-107 ²	D, see ^{99m} Rh	7E+4 St wall	2E+5	1E-4	3E-7	-	-
			W, see ^{99m} Rh Y, see ^{99m} Rh	(9E+4) - -	- 3E+5 3E+5	- 1E-4 1E-4	- 4E-7 3E-7	1E-3 - -	1E-2 - -
	45	Rhodium-99	D, see ^{99m} Rh W, see ^{99m} Rh Y, see ^{99m} Rh	2E+3 -	3E+3 2E+3 2E+3	1E-6 9E-7 8E-7	4E-9 3E-9 3E-9	3E-5 - -	3E-4 - -
	45	Rhodium-99m	D, all compounds except those given for W and Y W, halides Y, oxides and hydroxides	2E+4 -	6E+4 8E+4 7E+4	2E-5 3E-5 3E-5	8E-8 1E-7 9E-8	2E-4 - -	2E-3 -
	37	Rubidium-79 ²	D, all compounds	4E+4 St wall (6E+4)	1E+5 -	5E-5 -	2E-7 -	- 8E-4	- 8E-3

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
	Dellasselite	Class	Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
Atomic No.	Radionuclide		ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
37	Rubidium-81	D, all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
37	Rubidium-81m ²	D, all compounds	2E+5 St wall	3E+5	1E-4	5E-7	-	-
			(32+3)	_	-	-	42-3	42-2
37	Rubidium-82m	D, all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3
37	Rubidium-83	D, all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5
37	Rubidium-84	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-86	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-87	D, all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
37	Rubidium-88 ²	D, all compounds	2E+4 St wall	6E+4	3E-5	9E-8	-	-
			(32+4)	-	-	-	40-4	46-3
37	Rubidium-89 ⁻	D, all compounds	4E+4 St wall (6E+4)	1E+5 -	6E-5 -	2E-7 -	- 9E-4	- 9E-3
44	Ruthenium-103	D, see ⁹⁴ Ru	2E+3	2E+3	7E-7	2E-9	3E-5	3E-4
		W, see ⁹⁴ Ru Y, see ⁹⁴ Ru	-	1E+3 6E+2	4E-7 3E-7	1E-9 9E-10	-	-
44	Ruthenium-105	D, see ⁹⁴ Ru W, see ⁹⁴ Ru	5E+3 -	1E+4 1E+4	6E-6 6E-6	2E-8 2E-8	7E-5 -	7E-4 -
		Y, see Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-106	D, see ⁹⁴ Ru	2E+2 LLI wall	9E+1	4E-8	1E-10	-	-
		W, see ⁹⁴ Ru Y, see ⁹⁴ Ru	(2E+2) - -	- 5E+1 1E+1	- 2E-8 5E-9	- 8E-11 2E-11	3E-6 - -	3E-5 - -
44	Ruthenium-94 ²	D, all compounds except those given for W and Y W, halides Y, oxides and hydroxides	2E+4 - -	4E+4 6E+4 6E+4	2E-5 3E-5 2E-5	6E-8 9E-8 8E-8	2E-4 - -	2E-3 - -
44	Ruthenium-97	D, see ⁹⁴ Ru W, see ⁹⁴ Ru Y, see ⁹⁴ Ru	8E+3 - -	2E+4 1E+4 1E+4	8E-6 5E-6 5E-6	3E-8 2E-8 2E-8	1E-4 - -	1E-3 - -

				Table 4B1 Occupational Values		Tabl Eff Concer	e 4B2 luent ntrations	Table 4B3 Releases to Sewers
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
			Ingestion	Inhala	tion			Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air Water (μCi/ml) (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
62	Samarium 141 ²	W all compounds	5514	25.5	95 5	2E 7		
02	Samanum-141	w, all compounds	St wall (6E+4)	-	-	-	- 8E-4	- 8E-3
62	Samarium-141m ²	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-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	4E2	1E-11	-	-	-
			Bone surf (3E+1)	Bone surf (6E-2)	-	9E-14	3E-7	3E-6
62	Samarium-147	W, all compounds	2E+1	4E2	2E-11	-	-	-
			(3E+1)	(7E-2)	-	1E-13	4E-7	4E-6
62	Samarium-151	W, all compounds	1E+4	1E+2	4E-8	-	-	-
			(1E+4)	(2E+2)	-	2E-10	2E-4	2E-3
62	Samarium-153	W, all compounds	2E+3	3E+3	1E-6	4E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
62	Samarium-155 ²	W, all compounds	6E+4	2E+5	9E-5	3E-7	-	-
			(8E+4)	-	-	-	1E-3	1E-2
62	Samarium-156	W, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
21	Scandium-43	Y, all compounds	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
21	Scandium-44	Y, all compounds	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
21	Scandium-44m	Y, all compounds	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
21	Scandium-46	Y, all compounds	9E+2	2E+2	1E-7	3E-10	1E-5	1E-4
21	Scandium-47	Y, all compounds	2E+3 LLI wall (3E+3)	3E+3	1E-6	4E-9 -	- 4E-5	- 4E-4
21	Scandium-48	Y, all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
21	Scandium-49 ²	Y, all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3

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			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
		Class	Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
Atomic No.	Radionuclide		ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
34	Selenium-70 ²	D, all compounds except those given for W W, oxides, hydroxides, carbides, and	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
		elemental Se	1E+4	4E+4	2E-5	6E-8	-	-
34	Selenium-73	D, see ⁷⁰ Se W, see ⁷⁰ Se	3E+3 -	1E+4 2E+4	5E-6 7E-6	2E-8 2E-8	4E-5 -	4E-4 -
34	Selenium-73m ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	6E+4 3E+4	2E+5 1E+5	6E-5 6E-5	2E-7 2E-7	4E-4 -	4E-3
34	Selenium-75	D, see ⁷⁰ Se W, see ⁷⁰ Se	5E+2 -	7E+2 6E+2	3E-7 3E-7	1E-9 8E-10	7E-6	7E-5 -
34	Selenium-79	D, see ⁷⁰ Se W, see ⁷⁰ Se	6E+2	8E+2 6E+2	3E-7 2E-7	1E-9 8E-10	8E-6	8E-5 -
34	Selenium-81 ²	D, see ⁷⁰ Se	6E+4 St wall	2E+5	9E-5	3E-7	-	-
		W, see ⁷⁰ Se	(8E+4)	- 2E+5	- 1E-4	- 3E-7	1E-3 -	1E-2 -
34	Selenium-81m ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	4E+4 2E+4	7E+4 7E+4	3E-5 3E-5	9E-8 1E-7	3E-4 -	3E-3 -
34	Selenium-83 ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	4E+4 3E+4	1E+5 1E+5	5E-5 5E-5	2E-7 2E-7	4E-4 -	4E-3 -
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
		carbides, and nitrates Y, aluminosilicate glass	:	3E+4 3E+4	1E-5 1E-5	5E-8 4E-8	-	:
14	Silicon-32	D, see ³¹ Si	2E+3 LLI wall	2E+2	1E-7	3E-10	-	-
		W see ³¹ Si	(3E+3)	- 1E+2	- 5E-8	- 2E-10	4E-5	4E-4
		Y, see ³¹ Si	-	5E+0	2E-9	7E-12	-	-

I				Table 4B1 Occupational Values			e 4B2 luent htrations	Table 4B3 Releases to Sewers
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
47	Silver-102 ²	D, all compounds except those given for W and Y	5E+4 St wall	2E+5	8E-5	2E-7	-	-
		W, nitrates and sulfides Y, oxides and hydroxides	(6E+4) - -	- 2E+5 2E+5	- 9E-5 8E-5	- 3E-7 3E-7	9E-4 - -	9E-3 - -
47	Silver-103 ²	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	4E+4 - -	1E+5 1E+5 1E+5	4E-5 5E-5 5E-5	1E-7 2E-7 2E-7	5E-4 - -	5E-3 - -
47	Silver-104 ²	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	2E+4 - -	7E+4 1E+5 1E+5	3E-5 6E-5 6E-5	1E-7 2E-7 2E-7	3E-4 - -	3E-3 - -
47	Silver-104m ²	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	3E+4 - -	9E+4 1E+5 1E+5	4E-5 5E-5 5E-5	1E-7 2E-7 2E-7	4E-4 - -	4E-3 -
47	Silver-105	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	3E+3 - -	1E+3 2E+3 2E+3	4E-7 7E-7 7E-7	1E-9 2E-9 2E-9	4E-5 - -	4E-4 - -
47	Silver-106 ²	D, see ¹⁰² Ag	6E+4 St. wall (6E+4)	2E+5	8E-5 -	3E-7	- 9E-4	- 9E-3
		W, see ¹⁰² Ag Y, see ¹⁰² Ag	-	2E+5 2E+5	9E-5 8E-5	3E-7 3E-7	-	-
47	Silver-106m	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	8E+2 - -	7E+2 9E+2 9E+2	3E-7 4E-7 4E-7	1E-9 1E-9 1E-9	1E-5 - -	1E-4 - -
47	Silver-108m	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	6E+2 - -	2E+2 3E+2 2E+1	8E-8 1E-7 1E-8	3E-10 4E-10 3E-11	9E-6 - -	9E-5 - -
47	Silver-110m	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	5E+2 - -	1E+2 2E+2 9E+1	5E-8 8E-8 4E-8	2E-10 3E-10 1E-10	6E-6 - -	6E-5 - -
47	Silver-111	D, see ¹⁰² Ag	9E+2 LLI wall (1E+3)	2E+3 Liver (2E+3)	6E-7	- 2E-9	- 2E-5	- 2E-4
		W, see ¹⁰² Ag Y, see ¹⁰² Ag	-	9E+2 9E+2	4E-7 4E-7	1E-9 1E-9	-	-
47	Silver-112	D, see ¹⁰² Ag W, see ¹⁰² Ag Y, see ¹⁰² Ag	3E+3 - -	8E+3 1E+4 9E+3	3E-6 4E-6 4E-6	1E-8 1E-8 1E-8	4E-5 - -	4E-4 - -

				Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations	
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
			Indestion	Inhal	ation			Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
47	Silver-115 ²	D, see ¹⁰² Ag	3E+4 St wall	9E+4	4E-5	1E-7	-	-
		102	(3E+4)	-	-	-	4E-4	4E-3
		W, see Ag	-	9E+4	4E-5	1E-7	-	-
		r, see Ag	-	8E+4	3E-5	1E-/	-	-
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
38	Strontium-80 ²	D, all soluble compounds	15 0		55 0			a= 4
		except SrTiO	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		r, all insoluble com- pounds and SrTi0	-	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
	eachight of	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	-	-
			(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-85	D, see ⁸⁰ Sr	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
		Y, see ⁸⁰ Sr	-	2E+3	6E-7	2E-9	-	-
20	Strantium 95m ²	D 200 80 Sr	25.5	6E . E	25.4		2E 2	2E 0
30	Su onuuni-85m	Y, see ⁸⁰ Sr	2E+0 -	8E+5	3E-4 4E-4	9E-7 1E-6	3E-3 -	3E-2 -
38	Strontium-87m	D, see ⁸⁰ Sr	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
	eachight of the	Y, see ⁸⁰ Sr	4E+4	2E+5	6E-5	2E-7	-	-
38	Strontium-89	D, see ⁸⁰ Sr	6E+2	8E+2	4E-7	1E-9	-	-
			(6E+2)	-	-	-	8E-6	8E-5
		Y, see ⁸⁰ Sr	5E+2 ´	1E+2	6E-8	2E-10	-	-
38	Strontium-90	D, see ⁸⁰ Sr	3E+1 Bone surf	2E+1 Bone surf	8E-9	-	-	-
			(4E+1)	(2E+1)	-	3E-11	5E-7	5E-6
		Y, see ⁸⁰ Sr	- 1	4E+0 ´	2E-9	6E-12	-	-
20	Stroptium 01	D 500 80 Sr	25+3	6512	25 6	8E 0	25 5	25.4
30	30000000-91	Y, see ⁸⁰ Sr	2E+3 -	4E+3	2⊑-0 1E-6	5E-9	∠⊑-0 -	∠⊏-4 -
38	Strontium-92	D see ⁸⁰ Sr	3E+3	9F+3	4F-6	1F-8	4F-5	4F-4
50	0.0.0000002	Y see ⁸⁰ Sr	-	7E+3	35-6	ġĒ-ġ		-

	Radionuclide			Table 4B1 Occupational Values			e 4B2 luent htrations	Table 4B3 Releases to Sewers
Atomic No.		nuclide Class	Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (µCi)	Col. 3 Col. 1 DAC (μCi/ml)	<mark>Col. 1</mark> Air (μCi/ml)	Col. 2 Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
	0 % 07				25.0			
16	Sulfur-35	Vapor D, sulfides and sulfates	1E+4	6E-6	2E-8	-	-	
		except those given for W	1E+4 LLI wall	2E+4	7E-6	2E-8	-	-
		W, elemental sulfur, sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, and Mo. Sulfates of Ca, Sr,	(8E+3) 6E+3	-	-	-	1E-4	1E-3
		Ba, Ra, As, Sb, and Bi	-	2E+3	9E-7	3E-9	-	-
73	Tantalum-172 ²	W, all compounds except those given for Y Y, elemental Ta, oxides, hydroxides, halides,	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
		and nitrides	-	1E+5	4E-5	1E-7	-	-
73	Tantalum-173	W, see ¹⁷² Ta Y, see ¹⁷² Ta	7E+3 -	2E+4 2E+4	8E-6 7E-6	3E-8 2E-8	9E-5 -	9E-4
73	Tantalum-174 ²	W, see ¹⁷² Ta Y, see ¹⁷² Ta	3E+4 -	1E+5 9E+4	4E-5 4E-5	1E-7 1E-7	4E-4 -	4E-3 -
73	Tantalum-175	W, see ¹⁷² Ta Y, see ¹⁷² Ta	6E+3 -	2E+4 1E+4	7E-6 6E-6	2E-8 2E-8	8E-5 -	8E-4
73	Tantalum-176	W, see ¹⁷² Ta Y, see ^{1/2} Ta	4E+3 -	1E+4 1E+4	5E-6 5E-6	2E-8 2E-8	5E-5 -	5E-4 -
73	Tantalum-177	W, see ¹⁷² Ta Y, see ^{1/2} Ta	1E+4 -	2E+4 2E+4	8E-6 7E-6	3E-8 2E-8	2E-4 -	2E-3 -
73	Tantalum-178	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+4 -	9E+4 7E+4	4E-5 3E-5	1E-7 1E-7	2E-4 -	2E-3 -
73	Tantalum-179	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+4 -	5E+3 9E+2	2E-6 4E-7	8E-9 1E-9	3E-4 -	3E-3 -
73	Tantalum-180	W, see ¹⁷² Ta Y, see ¹⁷² Ta	1E+3 -	4E+2 2E+1	2E-7 1E-8	6E-10 3E-11	2E-5 -	2E-4 -
73	Tantalum-180m	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+4 -	7E+4 6E+4	3E-5 2E-5	9E-8 8E-8	3E-4 -	3E-3 -
73	Tantalum-182	W, see ¹⁷² Ta Y, see ¹⁷² Ta	8E+2 -	3E+2 1E+2	1E-7 6E-8	5E-10 2E-10	1E-5 -	1E-4 -

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I				Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
				Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
	73	Tantalum-182m ²	W, see ¹⁷² Ta	2E+5 St wall	5E+5	2E-4	8E-7	-	-
			Y, see ¹⁷² Ta	(2E+5)	- 4E+5	- 2E-4	- 6E-7	3E-3 -	3E-2 -
	73	Tantalum-183	W, see ¹⁷² Ta	9E+2 LLI wall	1E+3	5E-7	2E-9	-	-
			Y, see ¹⁷² Ta	(1E+3)	- 1E+3	- 4E-7	- 1E-9	2E-5 -	2E-4
	73	Tantalum-184	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+3 -	5E+3 5E+3	2E-6 2E-6	8E-9 7E-9	3E-5 -	3E-4 -
	73	Tantalum-185 ²	W, see ¹⁷² Ta Y, see ¹⁷² Ta	3E+4 -	7E+4 6E+4	3E-5 3E-5	1E-7 9E-8	4E-4 -	4E-3 -
	73	Tantalum-186 ²	W, see ¹⁷² Ta	5E+4 St wall	2E+5	1E-4	3E-7	-	-
			Y, see ¹⁷² Ta	(7E+4) -	- 2E+5	- 9E-5	- 3E-7	1E-3 -	1E-2 -
	43	Technetium-101 ²	D, see ^{93m} Tc	9E+4 St wall	3E+5	1E-4	5E-7	-	-
			W, see ^{93m} Tc	(1E+5) -	- 4E+5	- 2E-4	- 5E-7	2E-3 -	2E-2 -
	43	Technetium-104 ²	D, see ^{93m} Tc	2E+4 St wall	7E+4	3E-5	1E-7	-	-
			W, see ^{93m} Tc	(3E+4) -	- 9E+4	- 4E-5	- 1E-7	4E-4 -	4E-3 -
	43	Technetium-93	D, see ^{93m} Tc W, see ^{93m} Tc	3E+4 -	7E+4 1E+5	3E-5 4E-5	1E-7 1E-7	4E-4 -	4E-3 -
	43	Technetium-93m ²	D, all compounds except those given for W	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
			halides, and nitrates		3E+5	1E-4	4E-7	-	-
	43	Technetium-94	D, see ^{93m} Tc W, see ^{93m} Tc	9E+3 -	2E+4 2E+4	8E-6 1E-5	3E-8 3E-8	1E-4 -	1E-3 -
	43	Technetium-94m ²	D, see ^{93m} Tc W, see ^{93m} Tc	2E+4 -	4E+4 6E+4	2E-5 2E-5	6E-8 8E-8	3E-4 -	3E-3 -
	43	Technetium-95	D, see ^{93m} Tc W, see ^{93m} Tc	1E+4 -	2E+4 2E+4	9E-6 8E-6	3E-8 3E-8	1E-4 -	1E-3 -
	43	Technetium-95m	D, see ^{93m} Tc W, see ^{93m} Tc	4E+3 -	5E+3 2E+3	2E-6 8E-7	8E-9 3E-9	5E-5 -	5E-4 -

1				Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
1				Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
ļ	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
	43	Technetium-96	D, see ^{93m} Tc W, see ^{93m} Tc	2E+3 -	3E+3 2E+3	1E-6 9E-7	5E-9 3E-9	3E-5 -	3E-4
	43	Technetium-96m ²	D, see ^{93m} Tc W, see ^{93m} Tc	2E+5 -	3E+5 2E+5	1E-4 1E-4	4E-7 3E-7	2E-3 -	2E-2 -
	43	Technetium-97	D, see ^{93m} Tc W, see ^{93m} Tc	4E+4 -	5E+4 6E+3	2E-5 2E-6	7E-8 8E-9	5E-4 -	5E-3 -
	43	Technetium-97m	D, see ^{93m} Tc	5E+3 St woll	7E+3	3E-6	-	6E-5	6E-4
			W, see ^{93m} Tc	- -	(7E+3) 1E+3	- 5E-7	1E-8 2E-9	-	-
	43	Technetium-98	D, see ^{93m} Tc W, see ^{93m} Tc	1E+3 -	2E+3 3E+2	7E-7 1E-7	2E-9 4E-10	1E-5 -	1E-4 -
	43	Technetium-99	D, see ^{93m} Tc	4E+3	5E+3 St wall	2E-6	-	6E-5	6E-4
			W, see ^{93m} Tc	-	(6E+3) 7E+2	- 3E-7	8E-9 9E-10	-	:
	43	Technetium-99m	D, see ^{93m} Tc W, see ^{93m} Tc	8E+4 -	2E+5 2E+5	6E-5 1E-4	2E-7 3E-7	1E-3 -	1E-2 -
	52	Tellurium-116	D, all compounds except those given for W W oxides bydrovides	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
			and nitrates	-	3E+4	1E-5	4E-8	-	-
	52	Tellurium-121	D, see ¹¹⁶ Te W, see ¹¹⁶ Te	3E+3 -	4E+3 3E+3	2E-6 1E-6	6E-9 4E-9	4E-5 -	4E-4 -
	52	Tellurium-121m	D, see ¹¹⁶ Te	5E+2 Bone surf	2E+2 Bone surf	8E-8	-	-	-
			W, see ¹¹⁶ Te	(7E+2)	(4E+2) 4E+2	- 2E-7	5E-10 6E-10	1E-5 -	1E-4 -
	52	Tellurium-123	D, see ¹¹⁶ Te	5E+2 Bone surf	2E+2 Bone surf	8E-8	-	-	-
			W, see ¹¹⁶ Te	(1E+3)	(5E+2) 4E+2	- 2E-7	7E-10 -	2E-5 -	2E-4
				-	Bone suff (1E+3)	-	2E-9	-	-
	52	Tellurium-123m	D, see ¹¹⁶ Te	6E+2 Bone surf	2E+2 Bone surf	9E-8	-	-	-
			W, see ¹¹⁶ Te	(1E+3) -	(5E+2) 5E+2	- 2E-7	8E-10 8E-10	1E-5 -	1E-4 -

				Table 4B1 Occupational Values		Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
			Col. 1	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2		
			Oral	Inhala	Inhalation			Average	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (μCi/ml)	
52	Tellurium-125m	D, see ¹¹⁶ Te	1E+3 Bone surf	4E+2 Bone surf	2E-7	-	-	-	
		W, see ¹¹⁶ Te	(1E+3) -	(1E+3) 7E+2	- 3E-7	1E-9 1E-9	2E-5 -	2E-4 -	
52	Tellurium-127	D, see ¹¹⁶ Te W, see ¹¹⁶ Te	7E+3 -	2E+4 2E+4	9E-6 7E-6	3E-8 2E-8	1E-4 -	1E-3 -	
52	Tellurium-127m	D, see ¹¹⁶ Te	6E+2	3E+2 Bone surf	1E-7	-	9E-6	9E-5	
		W, see ¹¹⁶ Te	-	(4E+2) 3E+2	- 1E-7	6E-10 4E-10	-	-	
52	Tellurium-129 ²	D, see ¹¹⁶ Te W, see ¹¹⁶ Te	3E+4	6E+4 7E+4	3E-5 3E-5	9E-8 1E-7	4E-4	4E-3	
52	Tellurium-129m	D, see ¹¹⁶ Te W, see ¹¹⁶ Te	5E+2	6E+2 2E+2	3E-7 1E-7	9E-10 3E-10	7E-6	7E-5	
52	Tellurium-131 ²	D, see ¹¹⁶ Te	3E+3	5E+3 Thyroid	2E-6	-	-	-	
		W, see ¹¹⁶ Te	(6E+3)	(1E+4) 5E+3 Thyroid	- 2E-6	2E-8 -	8E-5 -	8E-4 -	
			-	(1E+4)	-	2E-8	-	-	
52	Tellurium-131m	D, see ¹¹⁶ Te	3E+2 Thyroid	4E+2 Thyroid	2E-7	-	-		
		W, see ¹¹⁶ Te	(6É+2)	(1Ě+3) 4E+2 Thyroid	- 2E-7	2E-9 -	8E-6 -	8E-5 -	
			-	(9E+2)	-	1E-9	-	-	
52	Tellurium-132	D, see ¹¹⁶ Te	2E+2 Thyroid	2E+2 Thyroid	9E-8	-	-	-	
		W, see ¹¹⁶ Te	(7É+2) -	(8É+2) 2E+2 Thyroid	- 9E-8	1E-9 -	9E-6 -	9E-5 -	
			-	(6E+2)	-	9E-10	-	-	
52	Tellurium-133 ²	D, see ¹¹⁶ Te	1E+4 Thyroid	2E+4 Thyroid	9E-6	-	-	-	
		W, see ¹¹⁶ Te	(3É+4) -	(6É+4) 2E+4 Thyroid	- 9E-6	8E-8 -	4E-4 -	4E-3 -	
			-	(6E+4)	-	8E-8	-	-	
52	Tellurium-133m ²	D, see ¹¹⁶ Te	3E+3 Thyroid	5E+3 Thyroid	2E-6	-	-	-	
		W, see ¹¹⁶ Te	(6E+3) -	(1E+4) 5E+3 Thyroid	- 2E-6	2E-8 -	9E-5 -	9E-4 -	
			-	(1É+4)	-	2E-8	-	-	

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I				Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
				Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1 Col. 2		Monthly
	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water nl) (μCi/ml)	Concentration (µCi/mI)
	52	Tellurium-134 ²	D, see ¹¹⁶ Te	2E+4	2E+4 Thyroid	1E-5	-		
			W, see ¹¹⁶ Te	(2E+4) -	(5E+4) 2E+4 Thyroid	- 1E-5	7E-8 - 7E-9	3E-4 -	3E-3 -
	05	Table 4472		-	(3E+4)	-	72-0	-	-
	65	Terblum-147	vv, all compounds	96+3	3E+4	1E-5	5E-8	16-4	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	vv, 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-156	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-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-157	W, all compounds	5E+4	3E+2 Bapa ourf	1E-7	-	-	-
				(5E+4)	(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 LLI wall	2E+3	7E-7	2E-9	-	-
				(2E+3)	-	-	-	3E-5	3E-4
	81	Thallium-194 ²	D, all compounds	3E+5 St wall	6E+5	2E-4	8E-7	-	-
				(3E+5)	-	-	-	4E-3	4E-2
	81	Thallium-194m ²	D, all compounds	5E+4 St wall (7E+4)	2E+5	6E-5 -	2E-7	- 1E-3	- 1F-2
	81	Thallium-195 ²	D, all compounds	6E+4	1E+5	5E-5	2E-7	9E-4	9E-3

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
81	Thallium-197	D. all compounds	7E+4	1E+5	5E-5	2E-7	1E-3	1E-2
81	Thallium-198	D. all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
81	Thallium-198m ²	D. all compounds	3E+4	5E+4	2E-5	8E-8	4E-4	4E-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	1F-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
90	Thorium-226 ²	W, all compounds except those given for Y	5E+3 St wall	2E+2	6E-8	2E-10	-	-
		Y, oxides and hydroxides	(5E+3)	- 1E+2	- 6E-8	- 2E-10	7E-5 -	7E-4 -
90	Thorium-227	W, see ²²⁶ Th Y, see ²²⁶ Th	1E+2 -	3E-1 3E-1	1E-10 1E-10	5E-13 5E-13	2E-6 -	2E-5 -
90	Thorium-228	W, see ²²⁶ Th	6E+0 Bone surf	1E-2 Bone surf	4E-12	-	-	-
		Y, see ²²⁶ Th	(1E+1) -	(2E-2) 2E-2	- 7E-12	3E-14 2E-14	2E-7 -	2E-6 -
90	Thorium-229	W, see ²²⁶ Th	6E-1 Bone surf	9E-4 Bone surf	4E-13	-	-	-
		Y, see ²²⁶ Th	(1E+0) -	(2E-3) 2E-3 Bone surf	- 1E-12	3E-15 -	2E-8 -	2E-7 -
			-	(3E-3)	-	4E-15	-	-
90	Thorium-230	W, see ²²⁶ Th	4E+0 Bone surf	6E-3 Bone surf	3E-12	-	-	-
		Y, see ²²⁶ Th	(9E+0) -	(2E-2) 2E-2 Bopo surf	- 6E-12	2E-14 -	1E-7 -	1E-6 -
			-	(2E-2)	-	3E-14	-	-
90	Thorium-231	W, see ²²⁶ Th Y, see ²²⁶ Th	4E+3	6E+3 6E+3	3E-6 3E-6	9E-9 9E-9	5E-5 -	5E-4

I				Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
l I				Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
I	Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (μCi/ml)
	90	Thorium-232	W, see ²²⁶ Th	7E-1 Bone surf	1E-3 Bone surf	5E-13	-	-	-
			Y, see ²²⁶ Th	(2E+0)	(3E-3) 3E-3 Bone surf	- 1E-12	4E-15 -	3E-8 -	3E-7
				-	(4E-3)	-	6E-15	-	-
	90	Thorium-234	W, see ²²⁶ Th	3E+2 LLI wall	2E+2	8E-8	3E-10	-	-
			Y, see ²²⁶ Th	(4E+2)	- 2E+2	- 6E-8	- 2E-10	5E-6 -	5E-5 -
	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 LLI wall	2E+3	8E-7	3E-9	-	-
				(2E+3)	-	-	-	3E-5	3E-4
	69	Thulium-170	W, all compounds	8E+2 LLI wall	2E+2	9E-8	3E-10	-	-
				(1E+3)	-	-	-	1E-5	1E-4
	69	Thulium-171	W, all compounds	1E+4 LLI wall	3E+2 Bone surf	1E-7	-	-	-
				(1E+4)	(6E+2)	-	8E-10	2E-4	2E-3
	69	Thulium-172	W, all compounds	7E+2 LLI wall	1E+3	5E-7	2E-9	-	-
				(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 St wall	3E+5	1E-4	4E-7	-	-
				(9E+4)	-	-	-	1E-3	1E-2
	50	Tin-110	D, all compounds except those given for W W, sulfides, oxides, hydroxides, halides,	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
			phosphate	-	1E+4	5E-6	2E-8	-	-
	50	Tin-111 ²	D, see ¹¹⁰ Sn W, see ¹¹⁰ Sn	7E+4 -	2E+5 3E+5	9E-5 1E-4	3E-7 4E-7	1E-3 -	1E-2 -

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				Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations	
			Col. 1 Oral Ingestion	Col. 2 Inhala	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
Atomic Radionuclide No.	Class	ALI (μCi)	ALI (μCi)	DAĊ (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/mI)	
50	Tin-113	D, see ¹¹⁰ Sn	2E+3 LLI wall	1E+3	5E-7	2E-9	-	-
		W, see ¹¹⁰ Sn	(2E+3)	- 5E+2	- 2E-7	- 8E-10	3E-5 -	3E-4 -
50	Tin-117m	D, see ¹¹⁰ Sn	2E+3	1E+3	5E-7	-	-	-
		W, see ¹¹⁰ Sn	(2E+3)	(2E+3) 1E+3	- 6E-7	3E-9 2E-9	3E-5 -	3E-4
50	Tin-119m	D, see ¹¹⁰ Sn	3E+3	2E+3	1E-6	3E-9	-	-
		W, see ¹¹⁰ Sn	(4E+3)	- 1E+3	- 4E-7	- 1E-9	6E-5 -	6E-4
50	Tin-121	D, see ¹¹⁰ Sn	6E+3	2E+4	6E-6	2E-8	-	-
		W. see ¹¹⁰ Sn	(6E+3)	- 1E+4	- 5E-6	- 2E-8	8E-5	8E-4
50	Tin-121m	D, see ¹¹⁰ Sn	3E+3	9E+2	4E-7	1E-9	-	-
		W, see ¹¹⁰ Sn	LLI wall (4E+3) -	- 5E+2	- 2E-7	- 8E-10	5E-5	5E-4
50	Tin-123	D, see ¹¹⁰ Sn	5E+2	6E+2	3E-7	9E-10	-	-
		W see ¹¹⁰ Sp	LLI wall (6E+2)	- 2E±2	- 7E-8	- 2E-10	9E-6	9E-5
50	Tin-123m ²	D, see ¹¹⁰ Sn	5E+4	1E+5	5E-5	2E-7	7E-4	7E-3
50	Tin-125	W, see […] Sn	- 4E+2	1E+5 9E+2	6E-5 4E-7	2E-7 1E-9	-	-
	120	5,000 011	LLI wall (5E+2)	-	-	-	6E-6	6E-5
	T : 100	W, see ¹¹⁰ Sn	-	4E+2	1E-7	5E-10	-	-
50	l in-126	D, see ¹¹⁰ Sn W, see ¹¹⁰ Sn	3E+2 -	6E+1 7E+1	2E-8 3E-8	8E-11 9E-11	4E-6 -	4E-5 -
50	Tin-127	D, see ¹¹⁰ Sn W, see ¹¹⁰ Sn	7E+3	2E+4 2E+4	8E-6 8E-6	3E-8 3E-8	9E-5 -	9E-4 -
50	Tin-128 ²	D, see ¹¹⁰ Sn W, see ¹¹⁰ Sn	9E+3	3E+4 4E+4	1E-5	4E-8 5E-8	1E-4	1E-3

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
Atomic	Radionuclide	dionuclide Class	Col. 1 Oral Ingestion ALI (uCi)	Col. 2 Inhala	Col. 3 Col. 1 tion DAC	Col. 1 Air	Col. 2 Water	Monthly Average Concentration	
No.			(μCi)	(μCi)	(μCi/ml)	(μCi/ml)	(μCi/ml)	(μCi/ml)	
22	Titanium-44	D, all compounds except those given for W and Y W, oxides, hydroxides, carbides, halides, and	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5	
		nitrates Y, SrTi0	-	3E+1 6E+0	1E-8 2E-9	4E-11 8E-12	-	-	
22	Titanium-45	D, see ⁴⁴ Ti W, see ⁴⁴ Ti Y, see ⁴⁴ Ti	9E+3 - -	3E+4 4E+4 3E+4	1E-5 1E-5 1E-5	3E-8 5E-8 4E-8	1E-4 - -	1E-3 - -	
74	Tungsten-176	D, all compounds	1E+4	5E+4	2E-5	7E-8	1E-4	1E-3	
74	Tungsten-177	D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3	
74	Tungsten-178	D, all compounds	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4	
74	Tungsten-179 ²	D, all compounds	5E+5	2E+6	7E-4	2E-6	7E-3	7E-2	
74	Tungsten-181	D, all compounds	2E+4	3E+4	1E-5	5E-8	2E-4	2E-3	
74	Tungsten-185	D, all compounds	2E+3 LLI wall (3E+3)	7E+3 -	3E-6	9E-9 -	- 4E-5	- 4E-4	
74	Tungsten-187	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4	
74	Tungsten-188	D, all compounds	4E+2 LLI wall	1E+3	5E-7	2E-9	-	-	
92	Uranium-230	D, UF, UOF, UO(NO)	4E+0 Bone surf	- 4E-1 Bone surf	- 2E-10	-	-	-	
		W, UO, UF, UCI Y, UO, UO	(6E+0) - -	(6E-1) 4E-1 3E-1	- 1E-10 1E-10	8E-13 5E-13 4E-13	8E-8 - -	8E-7 - -	
92	Uranium-231	D, see ²³⁰ U	5E+3 LLI wall (4E+3)	8E+3 -	3E-6	1E-8 -	- 6E-5	- 6E-4	
		W, see ²³⁰ U Y, see ²³⁰ U	-	6E+3 5E+3	2E-6 2E-6	8E-9 6E-9	-	-	
92	Uranium-232	D, see ²³⁰ U	2E+0 Bone surf (4E+0)	2E-1 Bone surf (4E-1)	9E-11	- 6E-13	- 6E-8	- 6E-7	
		W, see ²³⁰ U Y, see ²³⁰ U	-	4E-1 8E-3	2E-10 3E-12	5E-13 1E-14	-	-	

				Table 4B1 Occupational Values		Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)	
92	Uranium-233	D, see ²³⁰ U	1E+1	1E+0	5E-10	-	-	-	
		W/ soo ²³⁰ 11	Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6	
		Y, see ²³⁰ U	-	4E-2	2E-11	5E-14	-	-	
92	Uranium-234 ³	D, see ²³⁰ U	1E+1 Bone surf	1E+0 Bone surf	5E-10	-	-	-	
		W see 230	(2E+1)	(2E+0) 7E-1	- 3E-10	3E-12 1E-12	3E-7	3E-6	
		Y, see ²³⁰ U	-	4E-2	2E-11	5E-14	-	-	
92	Uranium-235 ³	D, see ²³⁰ U	1E+1 Bone surf	1E+0 Bone surf	6E-10	-	-	-	
		W see 230	(2E+1)	(2E+0) 8E-1	- 3E-10	3E-12	3E-7	3E-6	
		Y, see ²³⁰ U	-	4E-2	2E-11	6E-14	-	-	
92	Uranium-236	D, see ²³⁰ U	1E+1 Bone surf	1E+0 Bone surf	5E-10	-	-	-	
		W, see 230U	(2E+1)	(2E+0) 8E-1	- 3E-10	3E-12 1E-12	3E-7 -	3E-6 -	
		Y, see 230U	-	4E-2	2E-11	6E-14	-	-	
92	Uranium-237	D, see ²³⁰ U	2E+3 LLI wall	3E+3	1E-6	4E-9	-	-	
		W see 230	(2E+3)	- 2E+3	- 7E-7	- 2E-9	3E-5	3E-4	
		Y, see 230U	-	2E+3	6E-7	2E-9	-	-	
92	Uranium-2383	D, see ²³⁰ U	1E+1 Bone surf	1E+0 Bone surf	6E-10	-	-	-	
		W/ soo ²³⁰ 11	(2E+1)	(2E+0)	-	3E-12	3E-7	3E-6	
		Y, see ²³⁰ U	-	4E-2	2E-11	6E-14	-	-	
92	Uranium-239 ²	D, see ²³⁰ U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3	
		W, see ²³⁰ U Y, see ²³⁰ U	-	2E+5 2E+5	7E-5 6E-5	2E-7 2E-7	-	-	
92	Uranium-240	D, see ²³⁰ U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4	
		W, see ²³⁰ U Y, see ²³⁰ U	-	3E+3 2E+3	1E-6 1E-6	4E-9 3E-9	-	-	
92	Uranium-natural ³	D, see ²³⁰ U	1E+1 Bopo surf	1E+0 Bopo surf	5E-10	-	-	-	
		230	(2E+1)	(2E+0)	-	3E-12	3E-7	3E-6	
		W, see ²³⁰ U	-	8E-1	3E-10	9E-13	-	-	

I				Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
I				Col. 1	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Manthlu
1				Ingestion	Inhala	ion			Average
A	No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
	23	Vanadium-47 ²	D, all compounds except those given for W	3E+4 St wall	8E+4	3E-5	1E-7	-	
			W, oxides, hydroxides,	(3E+4)	-	-	-	4E-4	4E-3
			carbides, and halides	-	1E+5	4E-5	1E-7	-	-
	23	Vanadium-48	D, see ⁴⁷ V W, see ⁴⁷ V	6E+2	1E+3 6E+2	5E-7 3E-7	2E-9 9E-10	9E-6 -	9E-5 -
	23	Vanadium-49	D, see ⁴⁷ V	7E+4	3E+4	1E-5	-	-	-
			W, see ⁴⁷ V	(9E+4) -	(3E+4) 2E+4	- 8E-6	5E-8 2E-8	1E-3 -	1E-2 -
	54	Xenon-120 ²	Submersion ¹	-	-	1E-5	4E-8	-	-
	54	Xenon-121 ²	Submersion ¹	-	-	2E-6	1E-8	-	-
	54	Xenon-122	Submersion ¹	-	-	7E-5	3E-7	-	-
	54	Xenon-123	Submersion ¹	-	-	6E-6	3E-8	-	-
	54	Xenon-125	Submersion ¹	-	-	2E-5	7E-8	-	-
	54	Xenon-127	Submersion ¹	-	-	1E-5	6E-8	-	-
	54	Xenon-129m	Submersion ¹	-	-	2E-4	9E-7	-	-
	54	Xenon-131m	Submersion ¹	-	-	4E-4	2E-6	-	-
	54	Xenon-133	Submersion ¹	-	-	1E-4	5E-7	-	-
	54	Xenon-133m	Submersion ¹	-	-	1E-4	6E-7	-	-
	54	Xenon-135	Submersion ¹	-	-	1E-5	7E-8	-	-
	54	Xenon-135m ²	Submersion ¹	-	-	9E-6	4E-8	-	-
	54	Xenon-138 ²	Submersion ¹	-	-	4E-6	2E-8	-	-
	70	Ytterbium-162 ²	W, all compounds except those given for Y	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
			r, oxides, nyaroxides, and fluorides	-	3E+5	1E-4	4E-7	-	-
	70	Ytterbium-166	W, see ¹⁶² Yb Y, see ¹⁶² Yb	1E+3 -	2E+3 2E+3	8E-7 8E-7	3E-9 3E-9	2E-5 -	2E-4 -
	70	Ytterbium-167 ²	W, see ¹⁶² Yb Y, see ¹⁶² Yb	3E+5 -	8E+5 7E+5	3E-4 3E-4	1E-6 1E-6	4E-3	4E-2

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
Atomi	Radionuclida	Class	Col. 1 Oral Ingestion	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly Average
No.		Glass	(μCi)	(μCi)	(μCi/ml)	(μCi/ml)	(µCi/ml)	(µCi/ml)
70	Ytterbium-169	W, see ¹⁶² Yb Y, see ¹⁶² Yb	2E+3 -	8E+2 7E+2	4E-7 3E-7	1E-9 1E-9	2E-5 -	2E-4 -
70	Ytterbium-175	W, see ¹⁶² Yb	3E+3	4E+3	1E-6	5E-9	-	-
		Y, see ¹⁶² Yb	(3E+3)	- 3E+3	- 1E-6	- 5E-9	4E-5 -	4E-4 -
70	Ytterbium-177 ²	W, see ¹⁶² Yb Y, see ¹⁶² Yb	2E+4 -	5E+4 5E+4	2E-5 2E-5	7E-8 6E-8	2E-4 -	2E-3 -
70	Ytterbium-178 ²	W, see ¹⁶² Yb Y, see ¹⁶² Yb	1E+4 -	4E+4 4E+4	2E-5 2E-5	6E-8 5E-8	2E-4 -	2E-3 -
39	Yttrium-86	W, see ^{86m} Y Y, see ^{86m} Y	1E+3 -	3E+3 3E+3	1E-6 1E-6	5E-9 5E-9	2E-5 -	2E-4
39	Yttrium-86m ²	W, all compounds except those given for Y Y, oxides and hydroxides	2E+4	6E+4 5E+4	2E-5 2E-5	8E-8 8E-8	3E-4 -	3E-3 -
39	Yttrium-87	W, see ^{86m} Y Y, see ^{86m} Y	2E+3 -	3E+3 3E+3	1E-6 1E-6	5E-9 5E-9	3E-5 -	3E-4 -
39	Yttrium-88	W, see ^{86m} Y Y, see ^{86m} Y	1E+3 -	3E+2 2E+2	1E-7 1E-7	3E-10 3E-10	1E-5 -	1E-4 -
39	Yttrium-90	W, see ^{86m} Y	4E+2	7E+2	3E-7	9E-10	-	-
		Y, see ^{86m} Y	(5E+2)	- 6E+2	- 3E-7	- 9E-10	7E-6 -	7E-5 -
39	Yttrium-90m	W, see ^{86m} Y Y, see ^{86m} Y	8E+3 -	1E+4 1E+4	5E-6 5E-6	2E-8 2E-8	1E-4 -	1E-3 -
39	Yttrium-91	W, see ^{86m} Y	5E+2	2E+2	7E-8	2E-10	-	-
		Y, see ^{86m} Y	(6E+2)	- 1E+2	- 5E-8	- 2E-10	8E-6 -	8E-5 -
39	Yttrium-91m ²	W, see ^{86m} Y Y, see ^{86m} Y	1E+5 -	2E+5 2E+5	1E-4 7E-5	3E-7 2E-7	2E-3 -	2E-2
39	Yttrium-92	W, see ^{86m} Y Y, see ^{86m} Y	3E+3 -	9E+3 8E+3	4E-6 3E-6	1E-8 1E-8	4E-5 -	4E-4
39	Yttrium-93	W, see ^{86m} Y Y, see ^{86m} Y	1E+3 -	3E+3 2E+3	1E-6 1E-6	4E-9 3E-9	2E-5 -	2E-4

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			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water I) (µCi/ml)	Concentration (µCi/ml)
39	Yttrium-94 ²	W, see ^{86m} Y	2E+4 St wall	8E+4	3E-5	1E-7	-	-
		Y, see ^{86m} Y	(3E+4)	- 8E+4	- 3E-5	- 1E-7	4E-4 -	4E-3
39	Yttrium-95 ²	W, see ^{86m} Y	4E+4 St wall	2E+5	6E-5	2E-7	-	-
		Y, see ^{86m} Y	(5E+4)	- 1E+5	- 6E-5	- 2E-7	7E-4	7E-3
30	Zinc-62	Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
30	Zinc-63 ²	Y, all compounds	2E+4 St wall (3E+4)	7E+4	3E-5	9E-8 -	- 3E-4	- 3E-3
30	Zinc-65	Y. all compounds	4E+2	3E+2	1E-7	4E-10	5E-6	5E-5
30	Zinc-69 ²	Y. all compounds	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
30	Zinc-69m	Y. all compounds	4E+3	7E+3	3E-6	1E-8	6E-5	6E-4
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
40	Zirconium-86	D, all compounds except those given for W and Y W, oxides, hydroxides,	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		halides, and nitrates Y, carbide	-	3E+3 2E+3	1E-6 1E-6	4E-9 3E-9	-	:
40	Zirconium-88	D, see ⁸⁶ Zr W, see ⁸⁶ Zr	4E+3 -	2E+2 5E+2	9E-8 2E-7 1E-7	3E-10 7E-10	5E-5 -	5E-4 -
40	Zirconium-89	D, see $\frac{86}{2}$	- 2E+3	4E+3	1 <u>E</u> -6	4E-10 5E-9	- 2E-5	- 2E-4
		₩, see [∞] Zr Y, see ⁸⁶ Zr	-	2E+3 2E+3	1E-6 1E-6	3E-9 3E-9	-	-
40	Zirconium-93	D, see ⁸⁶ Zr	1E+3 Bone surf	6E+0 Bone surf	3E-9	-	-	-
		W, see ⁸⁶ Zr	(3E+3) -	(2E+1) 2E+1 Bone surf	- 1E-8	2E-11 -	4E-5 -	4E-4 -
		Y, see ⁸⁶ Zr	-	(6E+1) 6E+1 Bone surf	- 2E-8	9E-11 -	-	-
			-	(7E+1)	-	9E-11	-	-

			Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Col. 3 Col. 1		Col. 1 Col. 2		Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
40	Zirconium-95	D, see ⁸⁶ Zr	1E+3	1E+2 Bone surf	5E-8	-	2E-5	2E-4
		W, see ⁸⁶ Zr Y, see ⁸⁶ Zr	- -	(3E+2) 4E+2 3E+2	- 2E-7 1E-7	4E-10 5E-10 4E-10	-	-
40	Zirconium-97	D, see ⁸⁶ Zr W, see ⁸⁶ Zr Y, see ⁸⁶ Zr	6E+2 - -	2E+3 1E+3 1E+3	8E-7 6E-7 5E-7	3E-9 2E-9 2E-9	9E-6 - -	9E-5 - -
-	Any single radionuc above with decay n alpha emission or s sion and with radio life less than 2 hou	lide not listed pode other than pontaneous fis active half- rs Submersion ¹	-	2E+2	1E-7	1E-9	-	-
-	Any single radionuc above with decay n alpha emission or s sion and with radio life greater than 2 h	lide not listed pode other than pontaneous fis active half- iour	-	2E-1	1E-10	1E-12	1E-8	1E-7
-	Any single radionuc above that decays or spontaneous fiss ture for which eithe or the concentration nuclide in the mixtu	slide not listed by alpha emission sion, or any mix- r the identity n of any radio- re is not						
	known		-	4E-4	2E-13	1E-15	2E-9	2E-8

			Table 4B1 Occupational Values			le 4B2 luent ntrations	Table 4B3 Releases to Sewers
		Col. 1	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
		Ingestion	Inh	alation			Average
Atomic Radionuclide No.	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)

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.

 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

-	7E-4	3E-13	-	-	-
-	7E-3	3E-12	-		-
	7E-2	3E-11	-	-	-
-	7E-1	3E-10	-	-	-
	7E+0	3E-9	-	-	-
		- 7E-4 - 7E-3 - 7E-2 - 7E-1	 7E-4 3E-13 7E-3 3E-12 7E-2 3E-11 7E-1 3E-10 7E+0 3E-9 	· 7E-4 3E-13 · - 7E-3 3E-12 - - 7E-2 3E-11 - - 7E-1 3E-10 - - 7E+0 3E-9 -	· 7E-4 3E-13 · · · 7E-3 3E-12 · · · 7E-2 3E-11 · · · 7E-1 3E-10 · · · 7E+0 3E-9 · ·

	Table 4B1 Occupational Values			Table 4B2 Effluent Concentrations		Table 4B3 Releases to Sewers	
	Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly	
Atomic Radionuclide Class No.	Ingestion ALI (μCi)	gestion Inhalation ALI ALI DAC (μCi) (μCi) (μCi) (μCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Average Concentration (μCi/ml)		
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-238-Y, U-233-Y, U-234-Y, U-235-Y, U-236-W, U-238-W,Y, Pu-239-W,Y, Pu-240-W,Y, Pu-236-W, Pu-244-W,Y, Am-241-W, Am-242m-W, Am-243-W, Cm-244-W, Cm-245-W, Cm-246-W, Cm-247-W, Bk-247-W, Cf-249-W,Y, Cf-250-W,Y, Cf-251-W,Y, Cf-252-W,Y, and Cf-254-W,Y are not present	Y,	<u>.</u>	<u>.</u>	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-	-	<u>.</u>	<u>-</u>		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 µC of gross alpha activity from uranium-238, uranium-234, thorium-230, and radium-226 per milliliter of air; 3E-11 µC of natural uranium per milliliter of air; or 45 micrograms of natural uranium per cubic meter of air.

4. If the identity and concentration of each radionuclide in a mixture are known, the limiting values should be derived as follows: determine, for each radionuclide in the mixture, the ratio between the concentration present in the mixture and the concentration otherwise established in Appendix B to ' ' 20.1001 - 20.2401 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:

C _A	+	CB	C _B		
DACA		DACB		DACc	<u>≤</u> 1

			Table 4B1 Occupational Values			e 4B2 luent ntrations	Table 4B3 Releases to Sewers
		Col. 1 Oral	Col. 2	Col. 3 Col. 1	Col. 1	Col. 2	Monthly
		Ingestion	Inhalation				Average
Atomic Radionuclide No.	Class	ALI (μCi)	ALI (μCi)	DAC (µCi/ml)	Air (μCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)

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 <u>NOT</u> 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 ' 20.1203.)

³For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor (see ' 20.1201(e)). 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 gram U. The specific activity for other mixtures of U-238, U-234, if not known, shall be:

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

SA = $[0.4 + 0.38 \text{ (enrichment)} + 0.0034 \text{ (enrichment)}^2] \text{ E-6}$, enrichment ≥ 0.72

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

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