

Document #10

RQ

DRAFT 1 04/02/14

1 DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

2 Hazardous Materials and Waste Management Division

3 RADIATION CONTROL - TRANSPORTATION OF RADIOACTIVE MATERIAL

4 6 CCR 1007-1 Part 17

5 *[Editor's Notes follow the text of the rules at the end of this CCR Document.]*

6 PART 17: TRANSPORTATION OF RADIOACTIVE MATERIAL

7 GENERAL PROVISIONS

8 17.1 Purpose and Scope.

9 17.1.1 Authority.

10 Rules and regulations set forth herein are adopted pursuant to the provisions of sections 25-1-
11 108, 25-1.5-101(1)(l), and 25-11-104, CRS.

12 17.1.2 Basis and Purpose.

13 A statement of basis and purpose accompanies this part and changes to this part. A copy may be
14 obtained from the Department.

15 17.1.3 Scope.

16 This part establishes requirements for packaging, preparation for shipment, and transportation of
17 radioactive material.

18 17.1.4 Applicability.

19 17.1.4.1 This part applies to any person who transports radioactive material or delivers
20 radioactive material to a carrier for transport.21 (1) This part applies in particular to any licensee authorized by specific or general license
22 to receive, possess, use, or transfer licensed material, if the licensee delivers that
23 material to a carrier for transport, transports the material outside the site of usage
24 as specified in the license, or transports that material on a public highway.25 (2) The transport of licensed material or delivery of licensed material to a carrier for
26 transport is subject to the:27 (a) General provisions of 17.1 through 17.5, including referenced DOT
28 regulations;

29 (b) Quality assurance requirements of 17.10; and

30 (c) Operating controls and procedures requirements of 17.11 through 17.17.

31 (3) No provision of this part authorizes possession of licensed material.

32 (4) Exemptions from the requirement in 17.3 for a license are specified in 17.4.

Comment [JJ1]: EDITORIAL NOTE 1: ALL COMMENTS (SUCH AS THIS ONE) SHOWN IN THE RIGHT SIDE MARGIN OF THIS DOCUMENT ARE FOR INFORMATION PURPOSES ONLY TO PROVIDE ADDITIONAL INFORMATION AND TO AID THE READER IN UNDERSTANDING THE PROPOSED CHANGE DURING THE DRAFT REVIEW PROCESS.

THESE COMMENTS ARE **NOT** PART OF THE RULE AND ALL COMMENTS WILL BE DELETED PRIOR TO FINAL SUBMISSION TO THE COLORADO SECRETARY OF STATE'S OFFICE FOR FINAL PUBLISHING IN THE COLORADO CODE OF REGULATIONS.

EDITORIAL NOTE 2: THE ACRONYM "CRCPD" IN THE SIDE MARGIN NOTES REFERS TO THE CONFERENCE OF RADIATION CONTROL PROGRAM DIRECTORS (CRCPD), INC., WHICH DEVELOPS SUGGESTED STATE REGULATIONS FOR CONTROL OF RADIATION (SSRCR). UNLESS OTHERWISE DETERMINED BY THE BOARD OF HEALTH, COLORADO'S RULES ARE TO BE CONSISTENT WITH THE SSRCR REGULATIONS. THE SSRCRS MAY BE FOUND ONLINE AT:
<http://www.crcpd.org/ssrcrs/default.aspx>

NOTE THAT THE SSRCR'S MAY NOT REFLECT CURRENT REGULATORY CHANGES MADE BY THE U.S. NUCLEAR REGULATORY COMMISSION (NRC) IN THE CODE OF FEDERAL REGULATIONS (CFR'S). COMPATIBILITY WITH FEDERAL (NRC) REQUIREMENTS IS ALSO REQUIRED TO MAINTAIN AGREEMENT STATE STATUS. PROPOSED CHANGES IN COLORADO RULES MAY THEREFORE DEFAULT TO THE NRC RATHER THAN THOSE CONTAINED WITHIN AN SSRCR THAT IS NOT CURRENT. THE CRCPD SSRCR PART T (TRANSPORTATION) WAS LAST REVISED IN 1999 AND IS NOT CURRENT OR COMPATIBLE WITH ALL NRC REGULATORY REQUIREMENTS. THEREFORE, THE PROPOSED CHANGES HEREIN ARE FOR CONSISTENCY WITH NRC REGULATIONS.

EDITORIAL NOTE 3: INFORMATION ON NRC COMPATIBILITY CATEGORIES MAY BE FOUND AT:
<http://nrc-stp.ornl.gov/procedures/sa200.pdf>

EDITORIAL NOTE 4: INFORMATION ON NRC REGULATORY ACTION TRACKING SYSTEM (RATS) MAY BE FOUND AT:
<http://nrc-stp.ornl.gov/regtoolbox.html>

Document #10

RQ

DRAFT 1 04/02/14

33 (5) The general license under 17.7 requires that a NRC certificate of compliance or other
34 package approval be issued for the package to be used under the general
35 license.

36 (6) General licenses for which no package approval is required are issued in 17.8 and
37 17.9.

38 (7) These rules apply to any person required to obtain a certificate of compliance or an
39 approved compliance plan from the NRC pursuant to 10 CFR 71 if the person
40 delivers radioactive material to a common or contract carrier for transport or
41 transports the material outside the confines of the person's plant or other
42 authorized place of use.

43 17.1.4.2 The packaging and transport of radioactive material are also subject to other parts of
44 these regulations and to the regulations of other agencies (such as the DOT, the United
45 States Postal Service and the NRC) having jurisdiction over means of transport.

46 17.1.4.3 The requirements of this part are in addition to, and not in substitution for, other
47 requirements.

48 17.1.5 Published Material Incorporated by Reference.

49 Published material incorporated in Part 17 by reference is available in accord with Part 1, Section
50 1.4.

51 17.2 Definitions.

52 17.2.1 Definitions of general applicability to these regulations are in Part 1, Section 1.2.2.

53 17.2.2 Terms used in Part 17 have the definitions set forth as follows.

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

56 "Certificate holder" means a person who has been issued a certificate of compliance or other
57 package approval by the NRC.

58 "Certificate of Compliance" (COC) means the certificate issued by the NRC under subpart D of 10
59 CFR 71 (January 1, 2007~~14~~) which approves the design of a package for the transportation of
60 radioactive material.

61 "Closed transport vehicle" means a transport vehicle equipped with a securely attached
62 exterior enclosure that during normal transportation restricts the access of unauthorized persons
63 to the cargo space containing the radioactive material. The enclosure may be either temporary or
64 permanent but shall limit access from top, sides, and ends. In the case of packaged materials, it
65 may be of the "see-through" type.

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

68 "Containment system" means the assembly of components of the packaging intended to retain
69 the radioactive material during transport.

70 "Conveyance" means:

Document #10

RQ

DRAFT 1 04/02/14

- 71 (1) For transport by public highway or rail any transport vehicle or large freight container;
- 72 (2) For transport by water any vessel, or any hold, compartment, or defined deck area of
73 a vessel including any transport vehicle on board the vessel; and
- 74 (3) For transport by any aircraft.

75 "Criticality Safety Index (CSI)" means the dimensionless number (rounded up to the next tenth)
76 assigned to and placed on the label of a fissile material package, to designate the degree of
77 control of accumulation of packages containing fissile material during transportation.
78 Determination of the criticality safety index is described in 10 CFR 71.22, 71.23, and 71.59.

79 "Deuterium" means, for the purposes of Part 17, deuterium and any deuterium compound,
80 including heavy water, in which the ratio of deuterium atoms to hydrogen atoms exceeds 1:5000.

81 "Exclusive use" means the sole use by a single consignor of a conveyance for which all initial,
82 intermediate, and final loading and unloading are carried out in accordance with the direction of
83 the consignor or consignee. The consignor and the carrier must ensure that any loading or
84 unloading is performed by personnel having radiological training and resources appropriate for
85 safe handling of the consignment. The consignor must issue specific instructions, in writing, for
86 maintenance of exclusive use shipment controls, and include them with the shipping paper
87 information provided to the carrier by the consignor.

88 "Fissile material package" means a fissile material packaging together with its fissile material
89 contents.

90 "Graphite" means, for the purposes of Part 17, graphite with a boron equivalent content less than
91 5 parts per million and density greater than 1.5 grams per cubic centimeter.

92
93 **"Indian tribe" means an Indian or Alaska native tribe, band, nation, pueblo, village, or**
94 **community that the Secretary of the Interior acknowledges to exist as an Indian tribe**
95 **pursuant to the Federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. 479a.**

96 "Low specific activity material" (LSA material) means radioactive material with limited specific
97 activity which is nonfissile or except under Part 17 and which satisfies the descriptions and limits
98 set forth below. Shielding materials surrounding the LSA material may not be considered in
99 determining the estimated average specific activity of the package contents. LSA material must
100 be in one of three groups:

- 101 (1) LSA-I .
- 102 (a) Uranium and thorium ores, concentrates of uranium and thorium ores, and
103 other ores containing naturally occurring radionuclides which are not
104 intended to be processed for the use of these radionuclides; or
- 105 (b) **Solid unirradiated natural uranium or depleted uranium or natural**
106 **thorium or their solid or liquid compounds or mixtures.**
- 107 (c) Radioactive material, other than fissile material, for which the A_2 value in
108 Appendix 17A is unlimited; or
- 109 (d) Other radioactive material in which the activity is distributed throughout and
110 the estimated average specific activity does not exceed 30 times the
111 value for exempt material activity concentration determined in
112 accordance with Appendix 17A.

Comment [JJ2]: Definition added for compatibility with the requirements of 10 CFR Part 71.4

NRC Ref = 10 CFR 71.4
Compatibility = B
NRC Regulatory Action Tracking System (RATS)
2012-2 (#1)
[Due for state adoption = 08/10/2015]

Comment [JJ3]: Language added at the request of NRC, consistent with the requirements of 10 CFR Part 71.4. This language was omitted during a prior revision to Part 17.

NRC Ref = 10 CFR 71.4
NRC Ltr 10/15/07 (#1)
Compatibility = B
NRC RATS 2004-1

Document #10

RQ

DRAFT 1 04/02/14

- 113 (2) LSA-II .
- 114 (a) Water with tritium concentration up to 0.8 TBq/liter (20.0 Ci/liter); or
- 115 (b) Other radioactive material in which the activity is distributed throughout, and
116 the average specific activity does not exceed $10^{-4} \times A_2$ /g for solids
117 and gases, and $10^{-5} \times A_2$ /g for liquids.
- 118 (3) LSA-III . Solids in and for which:
- 119 (a) The radioactive material is distributed throughout a solid or a collection of
120 solid objects, or is essentially uniformly distributed in a solid compact
121 binding agent (such as concrete, bitumen, or ceramic); and
- 122 (b) The radioactive material is relatively insoluble, or it is intrinsically contained in
123 a relatively insoluble material, so that, even under loss of packaging, the
124 loss of radioactive material per package by leaching, when placed in
125 water for 7 days, would not exceed $0.1 \times A_2$;
- 126 (c) The estimated average specific activity of the solid does not exceed 2×10^{-3}
127 A_2 /g; and
- 128 (d) A specimen of the material has passed a leaching test, provided also that
129 any differences between the specimen tested and the material to be
130 transported were taken into account in determining whether the test
131 requirements have been met.
- 132 (i) The specimen, representing no less than the entire contents of the
133 package, must be immersed for 7 days in water at ambient
134 temperature;
- 135 (ii) The volume of water to be used in the test must be sufficient to
136 ensure that at the end of the test period the free volume of the
137 unabsorbed and unreacted water remaining will be at least 10%
138 of the volume of the specimen itself;
- 139 (iii) The water must have an initial pH of 6-8 and a maximum
140 conductivity 10 micromho/cm at 20°C (68°F); and
- 141 (iv) The total activity of the free volume of water must be measured
142 following the 7-day immersion test and must not exceed $0.1 \times A_2$
143 .
- 144 "Low toxicity alpha emitters" means natural uranium, depleted uranium, natural thorium; uranium-
145 235, uranium-238, thorium-232, thorium-228 or thorium-230 when contained in ores or physical or
146 chemical concentrates or tailings; or alpha emitters with a half-life of less than 10 days.
- 147 "Nuclear waste" means, for the purposes of Part 17, a quantity of source, byproduct or special
148 nuclear material required to be in NRC-approved specification packaging while transported to,
149 through or across a state boundary to a disposal site, or to a collection point for transport to a
150 disposal site.
- 151 "Packaging" means the assembly of components necessary to ensure compliance with the
152 packaging requirements of 10 CFR 71. It may consist of one or more receptacles, absorbent
153 materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or

Document #10

RQ

DRAFT 1 04/02/14

- 154 absorbing mechanical shocks. The vehicle, tie-down system, and auxiliary equipment may be
155 designated as part of the packaging.
- 156 "Quality assurance", for the purposes of Part 17, comprises all those planned and systematic
157 actions necessary to provide adequate confidence that a system or component will perform
158 satisfactorily in service.
- 159 "Quality control", for the purposes of Part 17, comprises those quality assurance actions that
160 relate to control of the physical characteristics and quality of the material or component to
161 predetermined requirements.
- 162 "Regulations of the DOT" means the regulations in 49 CFR Parts 100-189 and Parts 390-397
163 (October 1, 2006).
- 164 "Regulations of the NRC" means the regulations in 10 CFR 71 (January 1, 2007~~14~~) for
165 purposes of Part 17.
- 166 "Surface contaminated object" (SCO) means a solid object that is not itself classed as
167 radioactive material, but which has radioactive material distributed on any of its surfaces. The
168 SCO must be in one of two groups with surface activity not exceeding the following limits:
- 169 (1) SCO-I: a solid object on which:
- 170 (a) The non-fixed contamination on the accessible surface averaged over 300
171 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed
172 4 Bq/cm^2 (10^{-4} microcurie/ cm^2) for beta, gamma and low toxicity
173 alpha emitters, or 0.4 Bq/cm^2 (10^{-5} microcurie/ cm^2) for all other
174 alpha emitters;
- 175 (b) The fixed contamination on the accessible surface averaged over 300 cm^2
176 (or the area of the surface if less than 300 cm^2) does not exceed $4 \times$
177 10^4 Bq/cm^2 (1.0 microcurie/ cm^2) for beta, gamma and low toxicity
178 alpha emitters, or $4 \times 10^3 \text{ Bq/cm}^2$ (0.1 microcurie/ cm^2) for all other
179 alpha emitters; and
- 180 (c) The non-fixed contamination plus the fixed contamination on the inaccessible
181 surface averaged over 300 cm^2 (or the area of the surface if less than
182 300 cm^2) does not exceed $4 \times 10^4 \text{ Bq/cm}^2$ (1 microcurie/ cm^2) for
183 beta, gamma and low toxicity alpha emitters, or $4 \times 10^3 \text{ Bq/cm}^2$ (0.1
184 microcurie/ cm^2) for all other alpha emitters.
- 185 (2) SCO-II: a solid object on which the limits for SCO-I are exceeded and on which:
- 186 (a) The non-fixed contamination on the accessible surface averaged over 300
187 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed
188 400 Bq/cm^2 (10^{-2} microcurie/ cm^2) for beta, gamma and low toxicity
189 alpha emitters or 40 Bq/cm^2 (10^{-3} microcurie/ cm^2) for all other alpha
190 emitters;
- 191 (b) The fixed contamination on the accessible surface averaged over 300 cm^2
192 (or the area of the surface if less than 300 cm^2) does not exceed $8 \times$
193 10^5 Bq/cm^2 (20 microcuries/ cm^2) for beta, gamma and low toxicity
194 alpha emitters, or $8 \times 10^4 \text{ Bq/cm}^2$ (2 microcuries/ cm^2) for all other
195 alpha emitters; and

Document #10

RQ

DRAFT 1 04/02/14

196 (c) The non-fixed contamination plus the fixed contamination on the inaccessible
 197 surface averaged over 300 cm² (or the area of the surface if less than
 198 300 cm²) does not exceed 8 x 10⁵ Bq/cm² (20 microcuries/cm²)
 199 for beta, gamma and low toxicity alpha emitters, or 8 x 10⁴ Bq/cm² (2
 200 microcuries/cm²) for all other alpha emitters.

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

206
 207 "**Tribal official**" means the highest ranking individual that represents Tribal leadership,
 208 such as the Chief, President, or Tribal Council leadership.

Comment [JJ4]: Definition added for compatibility with the requirements of 10 CFR Part 71.4

209 "Type A package" means a Type A packaging that, together with its radioactive contents
 210 limited to A1 or A2 as appropriate, meets the requirements of 49 CFR 173.410 and 173.412 and
 211 is designed to retain the integrity of containment and shielding required by Part 17 under normal
 212 conditions of transport as demonstrated by the tests set forth in 49 CFR 173.465 or 173.466, as
 213 appropriate.

NRC Ref = 10 CFR 71.4
 Compatibility = B
 NRC RATS 2012-2 (#2)
 [Due for state adoption = 08/10/2015]

214 "Type A packaging" means a packaging designed for a Type A package.

215 "Type AF package", "Type BF package", "Type B(U)F package", and "Type B(M)F package"
 216 each means a fissile material packaging together with its fissile material contents.

217 "Type A quantity" means a quantity of radioactive material, the aggregate radioactivity of which
 218 does not exceed A1 for special form radioactive material or A2 for normal form radioactive
 219 material, where A1 and A2 are given in Appendix 17A or may be determined by procedures
 220 described in Appendix 17A.

221 "Type B package" means a Type B packaging together with its radioactive contents.2

222 2 A Type B package design is designated as B(U) or B(M). On approval, a Type B package design is designated by NRC as B(U)
 223 unless the package has a maximum normal operating pressure of more than 700kPa (100 lb/in2) gauge or a pressure relief device
 224 that would allow the release of radioactive material to the environment under the tests specified in 10 CFR 71.73 (hypothetical
 225 accident conditions), in which case it will receive a designation B(M). B(U) refers to the need for unilateral approval of international
 226 shipments; B(M) refers to the need for multilateral approval of international shipments. No distinction is made in how packages with
 227 these designations may be used in domestic transportation. To determine their distinction for international transportation, refer to 49
 228 CFR Part 173. A Type B package approved prior to September 6, 1983 was designated only as Type B; limitations on its use are
 229 specified in 17.8.

230 "Type B packaging" means a packaging designed to retain the integrity of containment and
 231 shielding when subjected to the normal conditions of transport and hypothetical accident test
 232 conditions set forth 10 CFR Part 71.

233 "Type B quantity" means a quantity of radioactive material greater than a Type A quantity.

234 LICENSE-RELATED REGULATORY REQUIREMENTS

235 17.3 Requirement for License.

236 No person shall transport radioactive material or deliver radioactive material to a carrier for
 237 transport except as authorized in a general or specific license issued by the Department, an
 238 Agreement State, a Licensing State, or NRC, or as exempted in 17.4

239 17.4 Exemptions.

Document #10

RQ

DRAFT 1 04/02/14

- 240 17.4.1 Common and contract carriers, freight forwarders, and warehouse workers which are subject to
 241 the requirements of the DOT in 49 CFR 170 through 189, or the U.S. Postal Service in the Postal
 242 Service Manual (Domestic Mail Manual), are exempt from the requirements of Part 17 to the
 243 extent that they transport or store radioactive material in the regular course of their carriage for
 244 others or storage incident thereto. Common and contract carriers who are not subject to the
 245 requirements of the DOT or U.S. Postal Service are subject to 17.3 and other applicable
 246 requirements of these regulations.
- 247 17.4.2 Any licensee is exempt from the requirements of Part 17 with respect to shipment or carriage of
 248 the following low-level materials:
- 249 17.4.2.1 Natural material and ores containing naturally occurring radionuclides that are not
 250 intended to be processed for use of these radionuclides, provided the activity
 251 concentration of the material does not exceed 10 times the values specified in Appendix
 252 17A, Table 17A2.
- 253 17.4.2.2 Materials for which the activity concentration is not greater than the activity
 254 concentration values specified in Appendix 17A, Table 17A2, or for which the
 255 consignment activity is not greater than the limit for an exempt consignment found in
 256 Appendix 17A, Table 17A2.
- 257 17.4.3 Fissile materials meeting the requirements of one of the paragraphs (a) through (f) in 10 CFR
 258 71.15 are exempt from classification as fissile material, and from the fissile material package
 259 standards of 10 CFR 71.55 and 10 CFR 71.59, but are subject to all other requirements of 10
 260 CFR 71, except as noted in paragraphs (a) through (f) in 10 CFR 71.15.
- 261 **17.4.4 Any physician licensed by a state to dispense drugs in the practice of medicine is exempt**
 262 **from 17.5 with respect to transport by the physician of licensed material for use in the**
 263 **practice of medicine. However, any physician operating under this exemption must be**
 264 **licensed under Part 7 or equivalent requirements of another Agreement State or NRC.**
- 265 **17.5 Transportation of Licensed Material.**
- 266 17.5.1 Each licensee who transports licensed material outside the site of usage, as specified in the
 267 Department license, or where transport is on public highways, or who delivers licensed material to
 268 a carrier for transport, shall:
- 269 17.5.1.1 Comply with the applicable requirements, appropriate to the mode of transport, of the
 270 regulations of the DOT, particularly the regulations of the DOT in the following areas:
- 271 (1) Packaging - 49 CFR Part 173: Subparts A and B and I.
- 272 (2) Marking and labeling - 49 CFR Part 172: Subpart D, § § 172.400 through 172.407, §
 273 § 172.436 through 172.441, and Subpart E.
- 274 (3) Placarding - 49 CFR Part 172: Subpart F, especially § § 172.500 through 172.519,
 275 172.556, and Appendices B and C.
- 276 (4) Accident reporting - 49 CFR Part 171: § § 171.15 and 171.16.
- 277 (5) Shipping papers and emergency information - 49 CFR Part 172: Subparts C and G.
- 278 (6) Hazardous material employee training - 49 CFR Part 172: Subpart H.
- 279 (7) Security plans - 49 CFR Part 172: Subpart I.

Comment [JJ5]: Language added at the request of NRC, consistent with the requirements of 10 CFR Part 71.13.

The added language provides an exemption from (standard) requirements and allows physicians to transport radioactive materials (typically radioactive drugs and/or certain devices containing radioactive materials) outside of U.S. Department of Transportation (DOT) requirements. The US DOT does not have an equivalent exception in their rules - only NRC has the exception in their rule.

This provision has been in place in NRC rule (10 CFR 71.13) for many years (~1972) and may have been put in place prior to the establishment of centralized nuclear pharmacy facilities. All new Agreement States are required to have the provision in their rules. Colorado and one other state may be the only Agreement States who have not implemented this provision.

This exemption was considered but expressly excluded by staff, and the Radiation Advisory Committee during the prior amendment(s) to Part 17 (most recently in 2007). The State Board of Health (BOH) concurred with the opinion of the staff and RAC to exclude this provision and did not adopt the change at that time.

Upon further evaluation It has been the experience of the Radiation Program that transportation of radioactive materials directly by physicians is rare.

Excluding the proposed provision (as has been done with prior amendments to Part 17) would continue to make Colorado's regulation not fully compatible with NRC regulations.

As a matter of compatibility and consistency with NRC rule and those of other Agreement States, the Radiation Program and Radiation Advisory Committee support inclusion of the proposed provision in Part 17 based upon the fact that such transport by physicians is a very infrequent event.

NRC Ref = 10 CFR 71.13
 NRC Ltr 10/15/07 (#2)
 Compatibility = [B]
 NRC RATS 2004-1

Document #10**RQ****DRAFT 1 04/02/14**

- 280 (8) Hazardous material shipper/carrier registration - 49 CFR Part 107: Subpart G.
- 281 17.5.1.2 The licensee shall also comply with applicable regulations of the DOT pertaining to the
282 following modes of transportation:
- 283 (1) Rail - 49 CFR Part 174: Subparts A through D, and K.
- 284 (2) Air - 49 CFR Part 175.
- 285 (3) Vessel - 49 CFR Part 176: Subparts A through F, and M.
- 286 (4) Public highway - 49 CFR Part 177 and Parts 390 through 397.
- 287 17.5.1.3 Assure that any special instructions needed to safely open the package are sent to or
288 have been made available to the consignee in accordance with 4.32.5.2.
- 289 17.5.2 If, for any reason, the regulations of the DOT are not applicable to a shipment of licensed material,
290 the licensee shall conform to the standards and requirements of 49 CFR Parts 170 through 189
291 appropriate to the mode of transport to the same extent as if the shipment was subject to these
292 regulations.

293 GENERAL LICENSES**294 17.6 General Licenses for Carriers.**

295 17.6.1 A general license is hereby issued to any common or contract carrier not exempt under 17.4 to
296 receive, possess, transport, and store radioactive material in the regular course of their carriage
297 for others or storage incident thereto, provided the transportation and storage is in accordance
298 with the applicable requirements, appropriate to the mode of transport, of the DOT insofar as
299 such requirements relate to the loading and storage of packages, placarding of the transporting
300 vehicle, and incident reporting.³

301 ³ Notification of an incident shall be filed with, or made to, the Department as prescribed in 49 CFR, regardless of and in addition to
302 the notification made to the DOT or other agencies.

303 17.6.2 A general license is hereby issued to any private carrier to transport radioactive material, provided
304 the transportation is in accordance with the applicable requirements, appropriate to the mode of
305 transport, of the DOT insofar as such requirements relate to the loading and storage of packages,
306 placarding of the transporting vehicle, and incident reporting.³

307 17.6.3 Persons who transport radioactive material pursuant to the general licenses in 17.6.1 and 17.6.2
308 are exempt from the requirements of Parts 4 and 10 of these regulations to the extent that they
309 transport radioactive material.

310 17.7 General License: NRC-Approved Packages.

311 17.7.1 A general license is hereby issued to any licensee of the Department to transport, or to deliver to
312 a carrier for transport, licensed material in a package for which a license, certificate of
313 compliance, or other approval has been issued by the NRC.

314 17.7.2 This general license applies only to a licensee who:

315 17.7.2.1 Has a quality assurance program approved by NRC as satisfying 10 CFR 71 Subpart H.

316 17.7.2.2 Has a copy of the specific license, certificate of compliance, or other approval by the
317 NRC of the package and has the drawings and other documents referenced in the

Document #10

RQ

DRAFT 1 04/02/14

- 318 approval relating to the use and maintenance of the packaging and to the action(s) to be
319 taken prior to shipment;
- 320 17.7.2.3 Complies with the terms and conditions of the license, certificate, or other approval by
321 the NRC, as applicable, and the applicable requirements of Part 17;
- 322 17.7.2.4 Prior to the licensee's first use of the package, has submitted to the NRC in writing in
323 accordance with 10 CFR 71.1:
- 324 (1) The licensee's name and license number; and
- 325 (2) The package identification number specified in the package approval; and
- 326 17.7.3 The general license in 17.7.1 applies only when the package approval authorizes use of the
327 package under this general license.
- 328 17.7.4 For a Type B or fissile material package, the design of which was approved by NRC before April
329 1, 1996, the general license in 17.7.1 is subject to additional restrictions of 10 CFR 71.19.
- 330 **17.8 General Licenses: Use of Foreign-Approved and Other Approved Packages**
- 331 17.8.1 A general license is issued to any licensee of the Department to transport, or to deliver to a carrier
332 for transport, licensed material in a package the design of which has been approved in a foreign
333 national competent authority certificate and revalidated by the DOT as meeting the applicable
334 requirements of 49 CFR 171.12. This general license applies only to:
- 335 17.8.1.1 Shipments made to or from locations outside the United States; and
- 336 17.8.1.2 A licensee who:
- 337 (1) Has a quality assurance program approved by NRC;
- 338 (2) Has a copy of the applicable certificate, the revalidation, and the drawings and other
339 documents referenced in the certificate, relating to the use and maintenance of
340 the packaging and to the actions to be taken prior to shipment;
- 341 (3) Complies with the terms and conditions of the certificate and revalidation; and
- 342 (4) Complies with ~~the each~~ applicable requirements of Part 17, **sections 17.1 through**
343 **17.5, 17.10 through 17.17, and 10 CFR 71 Subparts A, G, and H. With**
344 **respect to the quality assurance provisions of 10 CFR 71 Subpart H, the**
345 **licensee is exempt from design, construction, and fabrication**
346 **considerations.**
- 347 ~~17.8.2 A general license is issued to any licensee of the Department to transport, or to deliver to a carrier~~
348 ~~for transport, licensed material in a specification container for fissile material or for a Type B~~
349 ~~quantity of radioactive material as specified in 49 CFR Parts 173 and 178. This general license,~~
350 ~~which expires October 1, 2008:~~
- 351 17.8.2.1 ~~Is subject to the limitation that the specification container may not be used for a~~
352 ~~shipment to a location outside the United States except by multilateral approval as~~
353 ~~defined in 49 CFR 173.403;~~
- 354 17.8.2.2 ~~Applies only to a licensee who:~~

Comment [JJ6]: Language added at the request of NRC, consistent with the requirements of 10 CFR Part 71.21(d)(2). This language was omitted during a prior revision to Part 17.

The added language incorporates specific requirements found in specific sections of the regulatory part which are essentially equivalent to those found in federal rule.

NRC Ref = 10 CFR 71.21(d)(2)
NRC Ltr 10/15/07 (#3)
Compatibility = [B]
NRC RATS 2004-1

Comment [JJ7]: This section is deleted as it expired on October 1, 2008, consistent with federal rules of 10 CFR Part 71.20(e).

Document #10

RQ

DRAFT 1 04/02/14

- 355 ~~(1) Has a quality assurance program approved by NRC as satisfying 10 CFR 71 Subpart~~
 356 ~~H or equivalent approval satisfying the requirements of 17.10;~~
- 357 ~~(2) Has a copy of the specification;~~
- 358 ~~(3) Complies with the terms and conditions of the certificate and revalidation; and~~
- 359 ~~(4) Complies with each applicable requirement of Part 17.~~

360 **17.9 General Licenses: Fissile Material Transport**

361 17.9.1 A general license is hereby issued to any licensee to transport fissile material, or to deliver fissile
 362 material to a carrier for transport, if the licensee meets the requirements of 10 CFR 71.22 and the
 363 material is shipped in accordance with 10 CFR 71.22 and each applicable requirement of Part 17.

364 17.9.2 A general license is hereby issued to any licensee to transport fissile material in the form of
 365 plutonium-beryllium (Pu-Be) special form sealed sources, or to deliver fissile material in the form
 366 of plutonium-beryllium (Pu-Be) special form sealed sources to a carrier for transport, if the
 367 licensee meets the requirements of 10 CFR 71.23 and the material is shipped in accordance with
 368 10 CFR 71.23 and each applicable requirement of Part 17.

369 **QUALITY ASSURANCE**370 **17.10 Quality Assurance Requirements.**

371 17.10.1 Quality assurance requirements apply to design, purchase, fabrication, handling, shipping,
 372 storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, and modification
 373 of components of packaging that are important to safety.

374 17.10.1.1 The licensee, certificate holder, and applicant for a COC are responsible for complying
 375 with the quality assurance requirements which apply to design, fabrication, testing, and
 376 modification of packaging.

377 17.10.1.2 Each licensee is responsible for complying with each quality assurance provision
 378 which applies to the licensee's use of a packaging for the shipment of licensed material
 379 subject to the requirements of 10 CFR 71 and Part 17.

380 17.10.2 Each licensee, certificate holder, and applicant for a COC shall:

381 17.10.2.1 Be responsible to establish, maintain, and execute a quality assurance program that,
 382 using a graded approach to an extent that is commensurate with each quality assurance
 383 requirement's importance to safety, satisfies

384 (1) Each applicable criterion of 10 CFR 71.101 through 71.137; and

385 (2) Any specific provision that is applicable to the licensee's activities including
 386 procurement of packaging.

387 17.10.2.2 Be subject to each requirement that is applicable, whether the term "licensee" is or is
 388 not used in the requirement, for whatever design, fabrication, assembly, and testing of
 389 the package is accomplished with respect to a package before the time a package
 390 approval is issued.

391 17.10.3 Before the use of any package for the shipment of licensed material subject Part 17, each
 392 licensee shall obtain NRC approval of its quality assurance program.

Document #10

RQ

DRAFT 1 04/02/14

- 393 17.10.4 A program for transport container inspection and maintenance limited to radiographic exposure
 394 devices, source changers, or packages transporting these devices and meeting the requirements
 395 of 10 CFR 34.31(b), or equivalent Agreement State requirements, is deemed to satisfy the
 396 requirements of 17.7 and 17.10.2.
- 397 17.10.5 The licensee, certificate holder, and applicant for a COC shall be responsible for the
 398 establishment and execution of the quality assurance program.
- 399 17.10.5.1 The licensee, certificate holder, and applicant for a COC may delegate to others, such
 400 as contractors, agents, or consultants, the work of establishing and executing the quality
 401 assurance program, or any part of the quality assurance program, but shall retain
 402 responsibility for the program.
- 403 17.10.5.2 The licensee shall clearly establish and delineate, in writing, the authority and duties of
 404 persons and organizations performing activities affecting the safety-related functions of
 405 structures, systems, and components, including performing the functions associated with
 406 attaining quality objectives and the quality assurance functions.
- 407 17.10.6 The quality assurance functions are:
- 408 17.10.6.1 Assuring that an appropriate quality assurance program is established and effectively
 409 executed; and
- 410 17.10.6.2 Verifying, by procedures such as checking, auditing, and inspection, that activities
 411 affecting the safety-related functions have been performed correctly.
- 412 17.10.7 The persons and organizations performing quality assurance functions must have sufficient
 413 authority and organizational freedom to:
- 414 17.10.7.1 Identify quality problems;
- 415 17.10.7.2 Initiate, recommend, or provide solutions; and
- 416 17.10.7.3 Verify implementation of solutions.
- 417 **17.11 Advance Notification of Shipment of Irradiated Reactor Fuel and Transport of Nuclear**
 418 **Waste.**
- 419 17.11.1 **As specified in 17.11.3, 17.11.4, and 17.11.5, each licensee shall provide advance**
 420 **notification to the governor of a state, or the governor's designee, of the shipment of**
 421 **licensed material (irradiated reactor fuel and nuclear waste), within or across the boundary**
 422 **of the state, before the transport, or delivery to a carrier, for transport, of licensed material**
 423 **outside the confines of the licensee's plant or other place of use or storage. Prior to the**
 424 **transport of any nuclear waste outside of the confines of the licensee's facility or other place of**
 425 **use or storage, or prior to the delivery of any nuclear waste to a carrier for transport, each**
 426 **licensee shall provide advance notification of such transport to the governor, or governor's**
 427 **designee⁶, of each state through which the waste will be transported.**
- 428 ⁶ A list of the mailing addresses of the governors and governors' designees is available upon request from the Director, Office of
 429 State Programs, NRC, Washington, DC 20555. The list will be published annually in the Federal Register on or about June 30 to
 430 reflect any changes in information.
- 431 17.11.2 **As specified in 17.11.3, 17.11.4, and 17.11.5 of this section, after June 11, 2013, each**
 432 **licensee shall provide advance notification to the Tribal official of participating Tribes**
 433 **referenced in 17.11.4.3(3), or the official's designee, of the shipment of licensed material,**
 434 **within or across the boundary of the Tribe's reservation, before the transport, or delivery**

Comment [JJ8]: Language added/modified for consistency with the revised language of 10 CFR 71.97(a)(1).

NRC Ref = 10 CFR 71.97(a)(1)
 Compatibility = B
 NRC RATS 2012-2 (#3)
 [Due for state adoption = 08/10/2015]

Comment [JJ9]: Deleted text is incorporated into paragraph above.

Comment [JJ10]: The information contained in this footnote has been incorporated into the body of the rule in new Section 17.11.4.3(3), which also addresses comments of NRC letter dated 10/15/07.

DRAFT 1 04/02/14

435 to a carrier, for transport, of licensed material outside the confines of the licensee's plant
436 or other place of use or storage.

437 **17.11.3** Advance notification is also required under this section for the shipment of licensed
438 material, other than irradiated fuel, meeting the following three conditions only when:

439 17.11.23.1 The ~~nuclear waste~~ licensed material is required by this part to be in Type B
440 packaging for transportation;

441 17.11.23.2 The ~~nuclear waste~~ licensed material is being transported to or across a state
442 boundary into, within, or through, a state enroute route to a disposal facility or to a
443 collection point for transport to a disposal facility; and

444 17.11.23.3 The quantity of licensed material in a single package exceeds any one the least of the
445 following:

446 (1) 3000 times the ~~A₁~~A₁ value of the radionuclides as specified in Appendix 17A, Table
447 A1 for special form radioactive material; or

448 (2) 3000 times the ~~A₂~~A₂ value of the radionuclides as specified in Appendix 17A, Table
449 A1 for normal form radioactive material; or

450 (3) 1000 TBq (27,000 Ci);.

451 **17.11.4 Procedures for submitting advance notification**

452 **17.11.4.1 The notification must be made in writing to:**

453 (1) The office of each appropriate governor or governor's designee;

454 (2) The office of each appropriate Tribal official or Tribal official's designee;

455 (3) The NRC Director, Division of Security Policy, Office of Nuclear Security and
456 Incident Response.

457 **17.11.4.2 A notification delivered by mail must be postmarked at least 7 days before the**
458 **beginning of the 7 day period during which departure of the shipment is estimated to**
459 **occur.**

460 **17.11.4.3 A notification delivered by any other means than mail must reach the office of the**
461 **governor or of the governor's designee or the Tribal official, or Tribal official's designee at**
462 **least 4 days before the beginning of the 7-day period during which departure of the**
463 **shipment is estimated to occur.**

464 (1) A list of the names and mailing addresses of the governors' designees
465 receiving advance notification of transportation of nuclear waste was published in
466 the Federal Register on June 30, 1995 (60 FR 34306)

467 (2) The list of governor's designees and Tribal official's designees of participating
468 Tribes will be published annually in the Federal Register on or about June 30th to
469 reflect any changes in information.

470 (3) A list of the names and mailing addresses of the governor's designees and
471 Tribal official's designees of participating Tribes is available on request from the
472 Director, Division of Intergovernmental Liaison and Rulemaking, Office of Federal

Comment [JJ11]: Language of this paragraph added consistent with 10 CFR 71.97(a)(2).

The added language requires notifications to Tribal officials of participating Tribes when passing within or across a Tribal reservation.

NRC Ref = 10 CFR 71.97(a)(2)
Compatibility = B
NRC RATS 2012-2 (#3)
[Due for state adoption = 08/10/2015]

Comment [JJ12]: Language added/clarified in this section for consistency with 10 CFR 71.97(b).

Comment [JJ13]: Language added to section 17.11.4, for consistency with 10 CFR 71.97(c).

The added language provides for additional specific requirements related to notifications.

NRC Ref = 10 CFR 71.97(c)
Compatibility = B
NRC RATS 2012-2 (#4)
[Due for state adoption = 08/10/2015]

DRAFT 1 04/02/14

473 and State Materials and Environmental Management Programs, U.S. Nuclear
474 Regulatory Commission, Washington, DC 20555-0001.

475 17.11.4.4 The licensee shall retain a copy of the notification as a record for 3 years.

476 17.11.5 Information to be furnished in advance notification of shipment.

477 17.11.3.5.1 Each advance notification of shipment of irradiated reactor fuel or nuclear waste
478 required by 17.11.1 shall contain the following information:

479 17.11.3.(1) The name, address, and telephone number of the shipper, carrier, and
480 receiver of the irradiated reactor fuel or nuclear waste shipment;

481 17.11.3.(2) A description of the irradiated reactor fuel or nuclear waste contained in the
482 shipment, as required by 49 CFR 172.202 and 172.203(d);

483 17.11.3.(3) The point of origin of the shipment and the 7-day period during which
484 departure of the shipment is estimated to occur;

485 17.11.3.(4) The 7-day period during which arrival of the shipment at state boundaries or
486 Tribal reservation boundaries is estimated to occur;

487 17.11.3.(5) The destination of the shipment, and the 7-day period during which arrival of
488 the shipment is estimated to occur; and

489 17.11.3.(6) A point of contact with a telephone number for current shipment information.

490 ~~17.11.4 The notification required by 17.11.1 shall be made in writing to the office of each appropriate
491 governor, or governor's designee, and to the Department. A notification delivered by mail must be
492 postmarked at least 7 days before the beginning of the 7-day period during which departure of the
493 shipment is estimated to occur. A notification delivered by messenger must reach the office of the
494 governor, or governor's designee, at least 4 days before the beginning of the 7-day period during
495 which departure of the shipment is estimated to occur. A copy of the notification shall be retained
496 by the licensee for 3 years.~~

497 17.11.5.6 Revision notice

498 17.11.6.1 The licensee who finds that schedule information previously furnished to a
499 governor or governor's designee or a Tribal official or Tribal official's designee, in
500 accordance with this section, will not be met, shall:

501 (1) Telephone a responsible individual in the office of the governor of the state or
502 of the governor's designee or the Tribal official or Tribal official's designee an
503 inform that individual of the extent of the delay beyond the schedule originally
504 reported; and

505 (2) Maintain a record of the name of the individual contacted for 3 years. shall notify
506 each appropriate governor, or governor's designee, and the Department of any changes
507 to schedule information provided pursuant to 17.11.1. Such notification shall be by
508 telephone to a responsible individual in the office of the governor, or governor's designee,
509 of the appropriate state or states. The licensee shall maintain for 3 years a record of the
510 name of the individual contacted.

511

Comment [JJ14]: The addition/revision of this section is to correct a reference for the appropriate program within NRC.

NRC Letter 10/15/07 (#5)
NRC Ref = 10 CFR 71.97
Compatibility = B
NRC RATS 2004-1

Comment [JJ15]: Language added consistent with the requirements of 10 CFR Part 71.97(d).

The added language clarifies that the notification requirements apply to irradiated reactor fuel or nuclear waste. The added language also clarifies the Tribal notification requirements.

NRC Ref = 10 CFR 71.97(d)
Compatibility = B
NRC RATS 2012-2 (#6)
[Due for state adoption = 08/10/2015]

Comment [JJ16]: The requirements of this section are incorporated, with required modifications, into Section 17.11.4 (above).

Comment [JJ17]: Language added to section 17.11.6, for consistency with 10 CFR 71.97(e).

The added language clarifies what is required when a modifications pertaining to a shipment must be made.

NRC Ref = 10 CFR 71.97(e)
Compatibility = B
NRC RATS 2012-2 (#7)
[Due for state adoption = 08/10/2015]

Document #10

RQ

DRAFT 1 04/02/14

512 **17.11.7 Cancellation notice**

513 17.11.67.1 Each licensee who cancels an irradiated reactor fuel or nuclear waste shipment, for
 514 which advance notification has been sent, shall:

515 (1) Send a cancellation notice to the governor of each state, or governor's designee
 516 previously notified, each Tribal official or Tribal official's designee previously
 517 notified of each appropriate state and to the Department;:-

518 (2) State in the notice that it is a cancellation and identify the advance notification
 519 that is being cancelled; and

520 (3) Retain a copy of the notice shall be retained by the licensee for 3 years.

521 **17.12 Air Transport of Plutonium.**

522 Notwithstanding the provisions of any general licenses and notwithstanding any exemptions stated
 523 directly in this part or included indirectly by citation of the regulations of the DOT, as may be applicable,
 524 the licensee shall assure that plutonium in any form is not transported by air, or delivered to a carrier for
 525 air transport, unless:

526 17.12.1 The plutonium is contained in a medical device designed for individual human application; or

527 17.12.2 The plutonium is contained in a material in which the specific activity is less than or equal to the
 528 activity concentration values for plutonium specified in Appendix 17A, Table 17A-1, and in which
 529 the radioactivity is essentially uniformly distributed; or

530 17.12.3 The plutonium is shipped in a single package containing no more than an A2 quantity of
 531 plutonium in any isotope or form and is shipped in accordance with 17.5; or

532 17.12.4 The plutonium is shipped in a package specifically authorized (in the certificate of compliance
 533 issued by the NRC for that package) for the shipment of plutonium by air and the licensee
 534 requires, through special arrangement with the carrier, compliance with 49 CFR 175.704, the
 535 regulations of the DOT applicable to the air transport of plutonium.

536 **OPERATING CONTROLS AND PROCEDURES**537 **17.13 Fissile Material: Assumptions as to Unknown Properties of Fissile Material.**

538 When the isotopic abundance, mass, concentration, degree of irradiation, degree of moderation, or other
 539 pertinent property of fissile material in any package is not known, the licensee shall package the fissile
 540 material as if the unknown properties had credible values that would cause the maximum neutron
 541 multiplication.

542 **17.14 Preliminary Determinations.**

543 Prior to the first use of any packaging for the shipment of radioactive material:

544 17.14.1 The licensee shall ascertain that there are no defects which could significantly reduce the
 545 effectiveness of the packaging;

546 17.14.2 Where the maximum normal operating pressure will exceed 35 kilopascal (5 pounds per square
 547 inch) gauge, the licensee shall test the containment systems at an internal pressure at least 50
 548 percent higher than the maximum normal operating pressure to verify the capability of that
 549 system to maintain its structural integrity at that pressure;

Comment [JJ18]: Language added/clarified in section 17.11.7, for consistency with 10 CFR 71.97(f).

The added/revised language clarifies what is required when a reactor fuel or nuclear waste shipment is cancelled.

NRC Ref = 10 CFR 71.97(f)
 Compatibility = B
 NRC RATS 2012-2 (#8)
 [Due for state adoption = 08/10/2015]

Document #10

RQ

DRAFT 1 04/02/14

- 550 17.14.3 The licensee shall determine that the packaging has been fabricated in accordance with the
551 design approved by the NRC; and
- 552 17.14.4 The licensee shall conspicuously and durably mark the packaging with its model number, serial
553 number, gross weight, and a package identification number as assigned by the NRC.
- 554 **17.15 Routine Determinations.**
- 555 Prior to each shipment of licensed material, the licensee shall determine that:
- 556 17.15.1 The package is proper for the contents to be shipped;
- 557 17.15.2 The package is in unimpaired physical condition except for superficial defects such as marks or
558 dents;
- 559 17.15.3 Each closure device of the packaging, including any required gasket, is properly installed and
560 secured and free of defects;
- 561 17.15.4 Any system for containing liquid is adequately sealed and has adequate space or other specified
562 provision for expansion of the liquid;
- 563 17.15.5 Any pressure relief device is operable and set in accordance with written procedures;
- 564 17.15.6 The package has been loaded and closed in accordance with written procedures;
- 565 17.15.7 Any structural part of the package which could be used to lift or tie down the package during
566 transport is rendered inoperable for the purpose unless it satisfies design requirements specified
567 in 10 CFR 71.45;
- 568 17.15.8 The level of non-fixed (removable) radioactive contamination on the external surfaces of each
569 package offered for shipment is as low as reasonably achievable and within the limits specified in
570 49 CFR 173.443.
- 571 17.15.8.1 Determination of the level of non-fixed (removable) contamination shall be based upon
572 wiping an area of 300 square centimeters of the surface concerned with an absorbent
573 material, using moderate pressure, and measuring the activity on the wiping material.
- 574 (1) The number and location of measurements shall be sufficient to yield a
575 representative assessment of the removable contamination levels.
- 576 (2) Other methods of assessment of equal or greater detection efficiency may be used.
- 577 17.15.8.2 In the case of packages transported as exclusive use shipments by rail or highway
578 only, the non-fixed (removable) radioactive contamination:
- 579 (1) At the beginning of transport shall not exceed the levels specified in 49 CFR 173.443;
580 and
- 581 (2) At any time during transport shall not exceed 10 times the levels specified in 49 CFR
582 173.443.
- 583 17.15.9 External radiation levels around the package and around the vehicle, if applicable, shall not
584 exceed:

Document #10

RQ

DRAFT 1 04/02/14

- 585 17.15.9.1 2 mSv/h (200 millirem per hour) at any point on the external surface of the package at
586 any time during transportation;
- 587 17.15.9.2 A transport index of 10.0.
- 588 17.15.10 For a package transported in exclusive use by rail, highway or water, radiation levels external to
589 the package may exceed the limits specified in 17.15.9 but shall not exceed any of the following:
- 590 17.15.10.1 2 mSv/h (200 millirem per hour) on the accessible external surface of the package
591 unless the following conditions are met, in which case the limit is 10 mSv/h (1000 millirem
592 per hour);
- 593 (1) The shipment is made in a closed transport vehicle,
- 594 (2) Provisions are made to secure the package so that its position within the vehicle
595 remains fixed during transportation, and
- 596 (3) No loading or unloading operation occurs between the beginning and end of the
597 transportation.
- 598 17.15.10.2 2 mSv/h (200 millirem per hour) at any point on the outer surface of the vehicle,
599 including the upper and lower surfaces, or, in the case of a flat-bed style vehicle, with a
600 personnel barrier, at any point on the vertical planes projected from the outer edges of
601 the vehicle, on the upper surface of the load (or enclosure, if used), and on the lower
602 external surface of the vehicle;
- 603 (1) A flat bed style vehicle with a personnel barrier shall have radiation levels determined
604 at vertical planes.
- 605 (2) If no personnel barrier is in place, the package cannot exceed 2 mSv/h (200 millirem
606 per hour) at any accessible surface.
- 607 17.15.10.3 0.1 mSv/h (10 millirem per hour) at any point 2 meters from the vertical planes
608 represented by the outer lateral surfaces of the vehicle, or, in the case of a flat-bed style
609 vehicle, at any point 2 meters from the vertical planes projected from the outer edges of
610 the vehicle; and
- 611 17.15.10.4 0.02 mSv/h (2 millirem per hour) in any normally occupied positions of the vehicle,
612 except that this provision does not apply to private motor carriers when persons
613 occupying these positions are provided with special health supervision, personnel
614 radiation exposure monitoring devices, and training in accordance with 10.3; and
- 615 **17.15.11 For shipments made under the provisions of Section 17.15.10, the shipper shall provide**
616 **specific written instructions to the carrier for maintenance of the exclusive use shipment**
617 **controls. The instructions must be included with the shipping paper information.**
- 618 **17.15.12 The written instructions required for exclusive use shipments must be sufficient so that,**
619 **when followed, they will cause the carrier to avoid actions that will:**
- 620 **17.15.12.1 Unnecessarily delay delivery; or**
- 621 **17.15.12.2 Unnecessarily result in increased radiation levels or radiation exposures to**
622 **transport workers or members of the general public.**

Comment [JJ19]: The added language of 17.15.11, and 17.15.12 are at the request of NRC and are consistent with 10 CFR Part 71.47(c), and 71.47(d)

The added language specifies additional requirements for exclusive use shipments as required by federal rule. Refer to the definition for "exclusive use" in section 17.2, as similar requirements are also contained in the definition.

NRC Ref = 10 CFR 71.47(c), and 71.47(d)
NRC Ltr 10/15/07 (#4)
Compatibility = [B]
NRC RATS 2004-1

Document #10**RQ****DRAFT 1 04/02/14**

623 **17.15.13** A package must be prepared for transport so that in still air at 100 degrees Fahrenheit (38
624 degrees Celsius) and in the shade, no accessible surface of a package would have a temperature
625 exceeding 50 degrees Celsius (122 degrees Fahrenheit) in a nonexclusive use shipment or 82
626 degrees Celsius (185 degrees Fahrenheit) in an exclusive use shipment. Accessible package
627 surface temperatures shall not exceed these limits at any time during transportation.

628 17.15.14² A package may not incorporate a feature intended to allow continuous venting during
629 transport.

630 17.15.15³ Before delivery of a package to a carrier for transport, the licensee shall ensure that any
631 special instructions needed to safely open the package have been sent to the consignee, or
632 otherwise made available to the consignee, for the consignee's use in accordance with 4.32.5.2.

633 REPORTS AND RECORDS**634 17.16 Reports.**

635 The licensee shall report to the Department within 30 days:

636 17.16.1 Any instance in which there is significant reduction in the effectiveness of any packaging during
637 use; and

638 17.16.2 Details of any defects with safety significance in the packaging after first use, with the means
639 employed to repair the defects and prevent their recurrence; and

640 17.16.3 Instances in which the conditions of approval in the certificate of compliance were not observed
641 in making a shipment.

642 17.17 Shipment Records.

643 Each licensee shall maintain, for a period of 3 years after shipment, a record of each shipment of licensed
644 material not exempt under 17.4 showing, where applicable:

645 17.17.1 Identification of the packaging by model number and serial number;

646 17.17.2 Verification that the packaging, as shipped, had no significant defect;

647 17.17.3 Volume and identification of coolant;

648 17.17.4 Type and quantity of licensed material in each package, and the total quantity of each shipment;

649 17.17.5 Date of the shipment;

650 17.17.6 Name and address of the transferee;

651 17.17.7 Address to which the shipment was made; and

652 17.17.8 Results of the determinations required by 17.15 and by the conditions of the package approval.
653

Document #10

RQ

DRAFT 1 04/02/14

654 Appendix 17A - Determination of A₁ and A₂

655 17A1 Values of A₁ and A₂ for individual radionuclides, which are the bases for many activity limits
 656 elsewhere in these regulations are given in Table 17A1. The curie (Ci) values specified are
 657 obtained by converting from the Terabecquerel (TBq) figure. The Terabecquerel values are the
 658 regulatory standard. The curie values are for information only and are not intended to be the
 659 regulatory standard. The curie values are expressed to three significant figures to assure that the
 660 difference in the TBq and Ci quantities is one tenth of one percent or less. Where values of A₁
 661 or A₂ are unlimited, it is for radiation control purposes only. For nuclear criticality safety, some
 662 materials are subject to controls placed on fissile material.

663 17A2 For individual radionuclides whose identities are known, but which are:

664 17A2.1 Not listed in Table 17A1:

- 665 (1) The A₁ and A₂ values Table 17A3 may be used.
- 666 (2) Otherwise, the licensee shall obtain prior NRC approval of the A₁ and A₂ values
 667 for radionuclides not listed in Table 17A1, before shipping the material. The
 668 licensee shall submit such request for prior approval to NRC in accordance with
 669 10 CFR 71.1.

670 17A2.2 Not listed in Table 17A2:

- 671 (1) The exempt material activity concentration and exempt consignment activity values
 672 contained in Table 17A3 may be used.
- 673 (2) Otherwise, the licensee shall obtain prior NRC approval of the exempt material
 674 activity concentration and exempt consignment activity values for radionuclides
 675 not listed in Table 17A2, before shipping the material. The licensee shall submit
 676 such request for prior approval to NRC in accordance with 10 CFR 71.1.

677 17A3 In the calculations of A₁ and A₂ for a radionuclide not in Table 17A1, a single radioactive decay
 678 chain, in which radionuclides are present in their naturally occurring proportions, and in which no
 679 radioactive decay product nuclide has a half-life either longer than 10 days, or longer than that of
 680 the parent nuclide, shall be considered as a single radionuclide, and the activity to be taken into
 681 account, and the A₁ or A₂ value to be applied shall be those corresponding to the parent
 682 nuclide of that chain. In the case of radioactive decay chains in which any radioactive decay
 683 product nuclide has a half-life either longer than 10 days, or greater than that of the parent
 684 nuclide, the parent and those radioactive decay product nuclides shall be considered as mixtures
 685 of different nuclides.

686 17A4 For mixtures of radionuclides whose identities and respective activities are known, the following
 687 conditions apply:

688 17A4.1 For special form radioactive material, the maximum quantity transported in a Type A
 689 package is as follows:

690 1007-1_2007-00573_inline1.jpg

691 ~~$$\sum_i \frac{B(i)}{A_1(i)} - 1$$~~
$$\sum_i \frac{B(i)}{A_1(i)} \leq 1$$

692 where B(i) is the activity of radionuclide i, and A₁(i) is the A₁ value for radionuclide i.

Comment [JJ20]:
 EDITORIAL NOTE: The document used to generate this draft was downloaded from the Colorado Secretary of State (SOS) website. When downloaded, graphic images (such as symbols and equations) are not carried with the document and are instead treated as ".jpg" text in the document. Throughout this section there are multiple ".jpg" references. The ".jpg" references will not appear in the final rule as published by the SOS, and instead the actual symbol or equation will appear. Unless specifically shown, the symbols/equations will be shown as a ".jpg" text reference. There are no changes to these symbols or equations beyond the one specified in 17A4.1 (line 691).

Comment [JJ21]: At the request of NRC, the prior equation is deleted and replaced with the current equation to address a prior typographical error. The revised equation is equivalent to the equation found in 10 CFR 71, Appendix A, IV(a). The revised equation is equivalent to the deleted equation with the exception of the "≤" replacing the "<" symbol.
 EDITORIAL NOTE: The equation shown is generated by a symbol/equation generator and "strikeout" and "bold" text/fonts cannot be used with such equation generators. Therefore, a line is placed through the old equation to represent strikeout text. The equations were inserted into the document obtained from the SOS website and corrected to illustrate the proposed change.

NRC Ltr 10/15/07 (#7)
 Compatibility = B
 NRC RATS 2004-1

Document #10

RQ

DRAFT 1 04/02/14

693 17A4.2 For normal form radioactive material, the maximum quantity transported in a Type A
694 package is as follows:

695 1007-1_2007-00573_inline2.jpg

696 where $B(i)$ is the activity of radionuclide i , and $A_2(i)$ is the A_2 value for radionuclide i .

697 17A4.3 Alternatively, an A_1 value for mixtures of special form material may be determined as
698 follows:

699 1007-1_2007-00573_inline3.jpg

700 where $f(i)$ is the fraction of activity of nuclide i in the mixture and $A_1(i)$ is the appropriate
701 A_1 value for nuclide i .

702 17A4.4 Alternatively, the A_2 value for mixtures of normal form material may be determined as
703 follows:

704 1007-1_2007-00573_inline4.jpg

705 where $f(i)$ is the fraction of activity of nuclide i in the mixture and $A_2(i)$ is the appropriate
706 A_2 value for nuclide i .

707 17A4.5 The exempt activity concentration for mixtures of nuclides may be determined as follows:

708 1007-1_2007-00573_inline5.jpg

709 where $f(i)$ is the fraction of activity concentration of radionuclide i in the mixture, and $[A]$ is
710 the activity concentration for exempt material containing radionuclide i .

711 17A4.6 The activity limit for an exempt consignment for mixtures of radionuclides may be
712 determined as follows:

713 1007-1_2007-00573_inline6.jpg

714 where $f(i)$ is the fraction of activity of radionuclide i in the mixture, and A is the activity
715 limit for exempt consignments for radionuclide i .

716 17A5 When the identity of each radionuclide is known, but the individual activities of some of the
717 radionuclides are not known, the radionuclides may be grouped and the lowest A_1 or A_2 value,
718 as appropriate, for the radionuclides in each group may be used in applying the formulas in 17A4.
719 Groups may be based on the total alpha activity and the total beta/gamma activity when these are
720 known, using the lowest A_1 or A_2 values for the alpha emitters and beta/gamma emitters.

721 TABLE 17A1: A_1 AND A_2 VALUES FOR RADIONUCLIDES – Part 1 of 4

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (Tab)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
.	.	.	.	.	.	(TBq/g)	(Ci/g)
Ac-225 (a)	Actinium (89)	8.0×10^{-1}	2.2×10^1	6.0×10^{-3}	1.6×10^{-1}	2.1×10^3	5.8×10^4

Document #10

RQ

DRAFT 1 04/02/14

Ac-227 (a)	.	9.0X10 ⁻¹	2.4X10 ¹	9.0X10 ⁻⁵	2.4X10 ⁻³	2.7	7.2X10 ¹
Ac-228	.	6.0X10 ⁻¹	1.6X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	8.4X10 ⁴	2.2X10 ⁶
Ag-105	Silver (47)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	1.1X10 ³	3.0X10 ⁴
Ag-108m (a)	.	7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	9.7X10 ⁻¹	2.6X10 ¹
Ag-110m (a)	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.8X10 ²	4.7X10 ³
Ag-111	.	2.0	5.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	5.8X10 ³	1.6X10 ⁵
Al-26	Aluminum (13)	1.0X10 ⁻¹	2.7	1.0X10 ⁻¹	2.7	7.0X10 ⁻⁴	1.9X10 ⁻²
Am-241	Americium (95)	1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	1.3X10 ⁻¹	3.4
Am-242m (a)	.	1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	3.6X10 ⁻¹	1.0X10 ¹
Am-243 (a)	.	5.0	1.4X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	7.4X10 ⁻³	2.0X10 ⁻¹
Ar-37	Argon (18)	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	3.7X10 ³	9.9X10 ⁴
Ar-39	.	4.0X10 ¹	1.1X10 ³	2.0X10 ¹	5.4X10 ²	1.3	3.4X10 ¹
Ar-41	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.5X10 ⁶	4.2X10 ⁷
As-72	Arsenic (33)	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	6.2X10 ⁴	1.7X10 ⁶
As-73	.	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	8.2X10 ²	2.2X10 ⁴
As-74	.	1.0	2.7X10 ¹	9.0X10 ⁻¹	2.4X10 ¹	3.7X10 ³	9.9X10 ⁴
As-76	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	5.8X10 ⁴	1.6X10 ⁶
As-77	.	2.0X10 ¹	5.4X10 ²	7.0X10 ⁻¹	1.9X10 ¹	3.9X10 ⁴	1.0X10 ⁶
At-211 (a)	Astatine (85)	2.0X10 ¹	5.4X10 ²	5.0X10 ⁻¹	1.4X10 ¹	7.6X10 ⁴	2.1X10 ⁶
Au-193	Gold (79)	7.0	1.9X10 ²	2.0	5.4X10 ¹	3.4X10 ⁴	9.2X10 ⁵
Au-194	.	1.0	2.7X10 ¹	1.0	2.7X10 ¹	1.5X10 ⁴	4.1X10 ⁵
Au-195	.	1.0X10 ¹	2.7X10 ²	6.0	1.6X10 ²	1.4X10 ²	3.7X10 ³

Document #10

RQ

DRAFT 1 04/02/14

Au-198	.	1.0	2.7X10 ₁	6.0X10 ₋₁	1.6X10 ₁	9.0X10 _{0³}	2.4X10 _{0⁵}
Au-199	.	1.0X10 ₁	2.7X10 ₂	6.0X10 ₋₁	1.6X10 ₁	7.7X10 _{0³}	2.1X10 _{0⁵}
Ba-131 (a)	Barium (56)	2.0	5.4X10 ₁	2.0	5.4X10 ₁	3.1X10 _{0³}	8.4X10 _{0⁴}
Ba-133	.	3.0	8.1X10 ₁	3.0	8.1X10 ₁	9.4	2.6X10 _{0²}
Ba-133m	.	2.0X10 ₁	5.4X10 ₂	6.0X10 ₋₁	1.6X10 ₁	2.2X10 _{0⁴}	6.1X10 _{0⁵}
Ba-140 (a)	.	5.0X10 ₋₁	1.4X10 ₁	3.0X10 ₋₁	8.1	2.7X10 _{0³}	7.3X10 _{0⁴}
Be-7	Beryllium (4)	2.0X10 ₁	5.4X10 ₂	2.0X10 ₁	5.4X10 ₂	1.3X10 _{0⁴}	3.5X10 _{0⁵}
Be-10	.	4.0X10 ₁	1.1X10 ₃	6.0X10 ₋₁	1.6X10 ₁	8.3X10 _{0⁻⁴}	2.2X10 _{0⁻²}
Bi-205	Bismuth (83)	7.0X10 ₋₁	1.9X10 ₁	7.0X10 ₋₁	1.9X10 ₁	1.5X10 _{0³}	4.2X10 _{0⁴}
Bi-206	.	3.0X10 ₋₁	8.1	3.0X10 ₋₁	8.1	3.8X10 _{0³}	1.0X10 _{0⁵}
Bi-207	.	7.0X10 ₋₁	1.9X10 ₁	7.0X10 ₋₁	1.9X10 ₁	1.9	5.2X10 _{0¹}
Bi-210	.	1.0	2.7X10 ₁	6.0X10 ₋₁	1.6X10 ₁	4.6X10 _{0³}	1.2X10 _{0⁵}
Bi-210m (a)	.	6.0X10 ₋₁	1.6X10 ₁	2.0X10 ₋₂	5.4X10 ₋₁	2.1X10 _{0⁻⁵}	5.7X10 _{0⁻⁴}
Bi-212 (a)	.	7.0X10 ₋₁	1.9X10 ₁	6.0X10 ₋₁	1.6X10 ₁	5.4X10 _{0⁵}	1.5X10 _{0⁷}
Bk-247	Berkelium (97)	8.0	2.2X10 ₂	8.0X10 ₋₄	2.2X10 ₋₂	3.8X10 _{0⁻²}	1.0
Bk-249 (a)	.	4.0X10 ₁	1.1X10 ₃	3.0X10 ₋₁	8.1	6.1X10 _{0¹}	1.6X10 _{0³}
Br-76	Bromine (35)	4.0X10 ₋₁	1.1X10 ₁	4.0X10 ₋₁	1.1X10 ₁	9.4X10 _{0⁴}	2.5X10 _{0⁶}
Br-77	.	3.0	8.1X10 ₁	3.0	8.1X10 ₁	2.6X10 _{0⁴}	7.1X10 _{0⁵}
Br-82	.	4.0X10 ₋₁	1.1X10 ₁	4.0X10 ₋₁	1.1X10 ₁	4.0X10 _{0⁴}	1.1X10 _{0⁶}
C-11	Carbon (6)	1.0	2.7X10 ₁	6.0X10 ₋₁	1.6X10 ₁	3.1X10 _{0⁷}	8.4X10 _{0⁸}
C-14	.	4.0X10 ₁	1.1X10 ₃	3.0	8.1X10 ₁	1.6X10 _{0⁻¹}	4.5
Ca-41	Calcium (20)	Unlimited	Unlimited	Unlimited	Unlimited	3.1X10 _{0⁻³}	8.5X10 _{0⁻²}

Document #10

RQ

DRAFT 1 04/02/14

Ca-45	.	4.0×10^1	1.1×10^3	1.0	2.7×10^1	6.6×10^2	1.8×10^4
Ca-47 (a)	.	3.0	8.1×10^1	3.0×10^{-1}	8.1	2.3×10^4	6.1×10^5
Cd-109	Cadmium (48)	3.0×10^1	8.1×10^2	2.0	5.4×10^1	9.6×10^1	2.6×10^3
Cd-113m	.	4.0×10^1	1.1×10^3	5.0×10^{-1}	1.4×10^1	8.3	2.2×10^2
Cd-115 (a)	.	3.0	8.1×10^1	4.0×10^{-1}	1.1×10^1	1.9×10^4	5.1×10^5
Cd-115m	.	5.0×10^{-1}	1.4×10^1	5.0×10^{-1}	1.4×10^1	9.4×10^2	2.5×10^4
Ce-139	Cerium (58)	7.0	1.9×10^2	2.0	5.4×10^1	2.5×10^2	6.8×10^3
Ce-141	.	2.0×10^1	5.4×10^2	6.0×10^{-1}	1.6×10^1	1.1×10^3	2.8×10^4
Ce-143	.	9.0×10^{-1}	2.4×10^1	6.0×10^{-1}	1.6×10^1	2.5×10^4	6.6×10^5
Ce-144 (a)	.	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4	1.2×10^2	3.2×10^3
Cf-248	Californium (98)	4.0×10^1	1.1×10^3	6.0×10^{-3}	1.6×10^{-1}	5.8×10^1	1.6×10^3
Cf-249	.	3.0	8.1×10^1	8.0×10^{-4}	2.2×10^{-2}	1.5×10^{-1}	4.1
Cf-250	.	2.0×10^1	5.4×10^2	2.0×10^{-3}	5.4×10^{-2}	4.0	1.1×10^2
Cf-251	.	7.0	1.9×10^2	7.0×10^{-4}	1.9×10^{-2}	5.9×10^{-2}	1.6
Cf-252 (h)	.	5.0×10^{-2}	1.4	3.0×10^{-3}	8.1×10^{-2}	2.0×10^1	5.4×10^2
Cf-253 (a)	.	4.0×10^1	1.1×10^3	4.0×10^{-2}	1.1	1.1×10^3	2.9×10^4
Cf-254	.	1.0×10^{-3}	2.7×10^{-2}	1.0×10^{-3}	2.7×10^{-2}	3.1×10^2	8.5×10^3
Cl-36	Chlorine (17)	1.0×10^1	2.7×10^2	6.0×10^{-1}	1.6×10^1	1.2×10^{-3}	3.3×10^{-2}
Cl-38	.	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4	4.9×10^6	1.3×10^8
Cm-240	Curium (96)	4.0×10^1	1.1×10^3	2.0×10^{-2}	5.4×10^{-1}	7.5×10^2	2.0×10^4
Cm-241	.	2.0	5.4×10^1	1.0	2.7×10^1	6.1×10^2	1.7×10^4
Cm-242	.	4.0×10^1	1.1×10^3	1.0×10^{-2}	2.7×10^{-1}	1.2×10^2	3.3×10^3

Document #10

RQ

DRAFT 1 04/02/14

Cm-243	.	9.0	2.4X10 ₂	1.0X10 ₋₃	2.7X10 ₋₂	1.9X10 _{0⁻³}	5.2X10 _{0¹}
Cm-244	.	2.0X10 ₁	5.4X10 ₂	2.0X10 ₋₃	5.4X10 ₋₂	3.0	8.1X10 _{0¹}
Cm-245	.	9.0	2.4X10 ₂	9.0X10 ₋₄	2.4X10 ₋₂	6.4X10 _{0⁻³}	1.7X10 _{0⁻¹}
Cm-246	.	9.0	2.4X10 ₂	9.0X10 ₋₄	2.4X10 ₋₂	1.1X10 _{0⁻²}	3.1X10 _{0⁻¹}
Cm-247 (a)	.	3.0	8.1X10 ₁	1.0X10 ₋₃	2.7X10 ₋₂	3.4X10 _{0⁻⁶}	9.3X10 _{0⁻⁵}
Cm-248	.	2.0X10 ₋₂	5.4X10 ₋₁	3.0X10 ₋₄	8.1X10 ₋₃	1.6X10 _{0⁻⁴}	4.2X10 _{0⁻³}
Co-55	Cobalt (27)	5.0X10 ₋₁	1.4X10 ₁	5.0X10 ₋₁	1.4X10 ₁	1.1X10 _{0⁵}	3.1X10 _{0⁶}
Co-56	.	3.0X10 ₋₁	8.1	3.0X10 ₋₁	8.1	1.1X10 _{0³}	3.0X10 _{0⁴}
Co-57	.	1.0X10 ₁	2.7X10 ₂	1.0X10 ₁	2.7X10 ₂	3.1X10 _{0²}	8.4X10 _{0³}
Co-58	.	1.0	2.7X10 ₁	1.0	2.7X10 ₁	1.2X10 _{0³}	3.2X10 _{0⁴}
Co-58m	.	4.0X10 ₁	1.1X10 ₃	4.0X10 ₁	1.1X10 ₃	2.2X10 _{0⁵}	5.9X10 _{0⁶}
Co-60	.	4.0X10 ₋₁	1.1X10 ₁	4.0X10 ₋₁	1.1X10 ₁	4.2X10 _{0¹}	1.1X10 _{0³}
Cr-51	Chromium (24)	3.0X10 ₁	8.1X10 ₂	3.0X10 ₁	8.1X10 ₂	3.4X10 _{0³}	9.2X10 _{0⁴}
Cs-129	Cesium (55)	4.0	1.1X10 ₂	4.0	1.1X10 ₂	2.8X10 _{0⁴}	7.6X10 _{0⁵}
Cs-131	.	3.0X10 ₁	8.1X10 ₂	3.0X10 ₁	8.1X10 ₂	3.8X10 _{0³}	1.0X10 _{0⁵}
Cs-132	.	1.0	2.7X10 ₁	1.0	2.7X10 ₁	5.7X10 _{0³}	1.5X10 _{0⁵}
Cs-134	.	7.0X10 ₋₁	1.9X10 ₁	7.0X10 ₋₁	1.9X10 ₁	4.8X10 _{0¹}	1.3X10 _{0³}
Cs-134m	.	4.0X10 ₁	1.1X10 ₃	6.0X10 ₋₁	1.6X10 ₁	3.0X10 _{0⁵}	8.0X10 _{0⁶}
Cs-135	.	4.0X10 ₁	1.1X10 ₃	1.0	2.7X10 ₁	4.3X10 _{0⁻⁵}	1.2X10 _{0⁻³}
Cs-136	.	5.0X10 ₋₁	1.4X10 ₁	5.0X10 ₋₁	1.4X10 ₁	2.7X10 _{0³}	7.3X10 _{0⁴}
Cs-137 (a)	.	2.0	5.4X10 ₁	6.0X10 ₋₁	1.6X10 ₁	3.2	8.7X10 _{0¹}
Cu-64	Copper (29)	6.0	1.6X10 ₂	1.0	2.7X10 ₁	1.4X10 _{0⁵}	3.9X10 _{0⁶}

Document #10

RQ

DRAFT 1 04/02/14

Cu-67	.	1.0X10 ₁	2.7X10 ₂	7.0X10 ₋₁	1.9X10 ₁	2.8X10 ₀ ⁴	7.6X10 ₀ ⁵
Dy-159	Dysprosium (66)	2.0X10 ₁	5.4X10 ₂	2.0X10 ₁	5.4X10 ₂	2.1X10 ₀ ²	5.7X10 ₀ ³
Dy-165	.	9.0X10 ₋₁	2.4X10 ₁	6.0X10 ₋₁	1.6X10 ₁	3.0X10 ₀ ⁵	8.2X10 ₀ ⁶
Dy-166 (a)	.	9.0X10 ₋₁	2.4X10 ₁	3.0X10 ₋₁	8.1	8.6X10 ₀ ³	2.3X10 ₀ ⁵
Er-169	Erbium (68)	4.0X10 ₁	1.1X10 ₃	1.0	2.7X10 ₁	3.1X10 ₀ ³	8.3X10 ₀ ⁴
Er-171	.	8.0X10 ₋₁	2.2X10 ₁	5.0X10 ₋₁	1.4X10 ₁	9.0X10 ₀ ⁴	2.4X10 ₀ ⁶
Eu-147	Europium (63)	2.0	5.4X10 ₁	2.0	5.4X10 ₁	1.4X10 ₀ ³	3.7X10 ₀ ⁴

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TABLE 17A1: A₁ AND A₂ VALUES FOR RADIONUCLIDES – Part 2 of 4

Symbol. of. radionuclide	Element. atomic number	A ₁ (Tab)	A ₁ (Ci) ^b	A ₂ (TBq)	A ₂ (Ci) ^b	Specific activity (TBq/g)	Specific activity (Ci/g)
Eu-148	.	5.0X10 ₀ ⁻¹	1.4X10 ₀ ¹	5.0X10 ₀ ⁻¹	1.4X10 ₀ ¹	6.0X10 ⁻²	1.6X10 ⁻⁴
Eu-149	.	2.0X10 ₀ ¹	5.4X10 ₀ ²	2.0X10 ₀ ¹	5.4X10 ₀ ²	3.5X10 ⁻²	9.4X10 ⁻³
Eu-150. (short.lived)	.	2.0	5.4X10 ₀ ¹	7.0X10 ₀ ⁻¹	1.9X10 ₀ ¹	6.1X10 ⁻⁴	1.6X10 ⁻⁶
Eu-150. (long.lived)	.	7.0X10 ₀ ⁻¹	1.9X10 ₀ ¹	7.0X10 ₀ ⁻¹	1.9X10 ₀ ¹	6.1X10 ⁻⁴	1.6X10 ⁻⁶
Eu-152	.	1.0	2.7X10 ₀ ¹	1.0	2.7X10 ₀ ¹	6.5	1.8X10 ⁻²
Eu-152m	.	8.0X10 ₀ ⁻¹	2.2X10 ₀ ¹	8.0X10 ₀ ⁻¹	2.2X10 ₀ ¹	8.2X10 ⁻⁴	2.2X10 ⁻⁶
Eu-154	.	9.0X10 ₀ ⁻¹	2.4X10 ₀ ¹	6.0X10 ₀ ⁻¹	1.6X10 ₀ ¹	9.8	2.6X10 ⁻²
Eu-155	.	2.0X10 ₀ ¹	5.4X10 ₀ ²	3.0	8.1X10 ₀ ¹	1.8X10 ⁻¹	4.9X10 ⁻²
Eu-156	.	7.0X10 ₀ ⁻¹	1.9X10 ₀ ¹	7.0X10 ₀ ⁻¹	1.9X10 ₀ ¹	2.0X10 ⁻³	5.5X10 ⁻⁴
F-18	Fluorine.(9)	1.0	2.7X10 ₀ ¹	6.0X10 ₀ ⁻¹	1.6X10 ₀ ¹	3.5X10 ⁻⁶	9.5X10 ⁻⁷

Document #10

RQ

DRAFT 1 04/02/14

Fe-52.(a)	Iron.(26)	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	2.7X10 ⁻⁵	7.3X10 ⁻⁶
Fe-55	.	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	8.8X10 ⁻¹	2.4X10 ⁻³
Fe-59	.	9.0X10 ⁻¹	2.4X10 ¹	9.0X10 ⁻¹	2.4X10 ¹	1.8X10 ⁻³	5.0X10 ⁻⁴
Fe-60.(a)	.	4.0X10 ¹	1.1X10 ³	2.0X10 ⁻¹	5.4	7.4X10 ⁻⁴	2.0X10 ⁻²
Ga-67	Gallium.(31)	7.0	1.9X10 ²	3.0	8.1X10 ¹	2.2X10 ⁻⁴	6.0X10 ⁻⁵
Ga-68	.	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	1.5X10 ⁻⁶	4.1X10 ⁻⁷
Ga-72	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.1X10 ⁻⁵	3.1X10 ⁻⁶
Gd-146.(a)	Gadolinium.(64)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	6.9X10 ⁻²	1.9X10 ⁻⁴
Gd-148	.	2.0X10 ¹	5.4X10 ²	2.0X10 ⁻³	5.4X10 ⁻²	1.2	3.2X10 ⁻¹
Gd-153	.	1.0X10 ¹	2.7X10 ²	9.0	2.4X10 ²	1.3X10 ⁻²	3.5X10 ⁻³
Gd-159	.	3.0	8.1X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.9X10 ⁻⁴	1.1X10 ⁻⁶
Ge-68.(a)	Germanium.(32)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	2.6X10 ⁻²	7.1X10 ⁻³
Ge-71	.	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	5.8X10 ⁻³	1.6X10 ⁻⁵
Ge-77	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.3X10 ⁻⁵	3.6X10 ⁻⁶
Hf-172.(a)	Hafnium.(72)	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	4.1X10 ⁻¹	1.1X10 ⁻³
Hf-175	.	3.0	8.1X10 ¹	3.0	8.1X10 ¹	3.9X10 ⁻²	1.1X10 ⁻⁴
Hf-181	.	2.0	5.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	6.3X10 ⁻²	1.7X10 ⁻⁴
Hf-182	.	Unlimited	Unlimited	Unlimited	Unlimited	8.1X10 ⁻⁶	2.2X10 ⁻⁴
Hg-194.(a)	Mercury.(80)	1.0	2.7X10 ¹	1.0	2.7X10 ¹	1.3X10 ⁻¹	3.5
Hg-195m.(a)	.	3.0	8.1X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	1.5X10 ⁻⁴	4.0X10 ⁻⁵
Hg-197	.	2.0X10 ¹	5.4X10 ²	1.0X10 ¹	2.7X10 ²	9.2X10 ⁻³	2.5X10 ⁻⁵
Hg-	.	1.0X1	2.7X1	4.0X1	1.1X1	2.5X10 ⁻⁴	6.7X10 ⁻⁵

Document #10

RQ

DRAFT 1 04/02/14

197m		0 ¹	0 ²	0 ⁻¹	0 ¹		
Hg-203	.	5.0	1.4X10 ²	1.0	2.7X10 ¹	5.1X10 ⁻²	1.4X10 ⁴
Ho-166	Holmium.(67)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	2.6X10 ⁻⁴	7.0X10 ⁻⁵
Ho-166m	.	6.0X10 ⁻¹	1.6X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	6.6X10 ⁻²	1.8
I-123	Iodine.(53)	6.0	1.6X10 ²	3.0	8.1X10 ¹	7.1X10 ⁻⁴	1.9X10 ⁶
I-124	.	1.0	2.7X10 ¹	1.0	2.7X10 ¹	9.3X10 ⁻³	2.5X10 ⁻⁵
I-125	.	2.0X10 ¹	5.4X10 ²	3.0	8.1X10 ¹	6.4X10 ⁻²	1.7X10 ⁻⁴
I-126	.	2.0	5.4X10 ¹	1.0	2.7X10 ¹	2.9X10 ⁻³	8.0X10 ⁻⁴
I-129	.	Unlimited	Unlimited	Unlimited	Unlimited	6.5X10 ⁻⁶	1.8X10 ⁻⁴
I-131	.	3.0	8.1X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	4.6X10 ⁻³	1.2X10 ⁻⁵
I-132	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	3.8X10 ⁻⁵	1.0X10 ⁻⁷
I-133	.	7.0X10 ⁻¹	1.9X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	4.2X10 ⁻⁴	1.1X10 ⁻⁶
I-134	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	9.9X10 ⁻⁵	2.7X10 ⁻⁷
I-135.(a)	.	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.3X10 ⁻⁵	3.5X10 ⁻⁶
In-111	Indium.(49)	3.0	8.1X10 ¹	3.0	8.1X10 ¹	1.5X10 ⁻⁴	4.2X10 ⁻⁵
In-113m	.	4.0	1.1X10 ²	2.0	5.4X10 ¹	6.2X10 ⁻⁵	1.7X10 ⁻⁷
In-114m.(a)	.	1.0X10 ¹	2.7X10 ²	5.0X10 ⁻¹	1.4X10 ¹	8.6X10 ⁻²	2.3X10 ⁻⁴
In-115m	.	7.0	1.9X10 ²	1.0	2.7X10 ¹	2.2X10 ⁻⁵	6.1X10 ⁻⁶
Ir-189.(a)	Iridium.(77)	1.0X10 ¹	2.7X10 ²	1.0X10 ¹	2.7X10 ²	1.9X10 ⁻³	5.2X10 ⁻⁴
Ir-190	.	7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	2.3X10 ⁻³	6.2X10 ⁻⁴
Ir-192.(c)	.	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.4X10 ⁻²	9.2X10 ⁻³
Ir-194	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	3.1X10 ⁻⁴	8.4X10 ⁻⁵

Document #10

RQ

DRAFT 1 04/02/14

K-40	Potassium.(19)	9.0X10 ⁻¹	2.4X10 ¹	9.0X10 ⁻¹	2.4X10 ¹	2.4X10 ⁻⁷	6.4X10 ⁻⁶
K-42	.	2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	2.2X10 ⁻⁵	6.0X10 ⁻⁶
K-43	.	7.0X10 ⁻¹	1.9X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.2X10 ⁻⁵	3.3X10 ⁻⁶
Kr-81	Krypton.(36)	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	7.8X10 ⁻⁴	2.1X10 ⁻²
Kr-85	.	1.0X10 ¹	2.7X10 ²	1.0X10 ¹	2.7X10 ²	1.5X10 ¹	3.9X10 ²
Kr-85m	.	8.0	2.2X10 ²	3.0	8.1X10 ¹	3.0X10 ⁻⁵	8.2X10 ⁻⁶
Kr-87	.	2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	1.0X10 ⁻⁶	2.8X10 ⁻⁷
La-137	Lanthanum.(57)	3.0X10 ¹	8.1X10 ²	6.0	1.6X10 ²	1.6X10 ⁻³	4.4X10 ⁻²
La-140	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	2.1X10 ⁻⁴	5.6X10 ⁻⁵
Lu-172	Lutetium.(71)	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	4.2X10 ⁻³	1.1X10 ⁻⁵
Lu-173	.	8.0	2.2X10 ²	8.0	2.2X10 ²	5.6X10 ⁻¹	1.5X10 ⁻³
Lu-174	.	9.0	2.4X10 ²	9.0	2.4X10 ²	2.3X10 ⁻¹	6.2X10 ⁻²
Lu-174m	.	2.0X10 ¹	5.4X10 ²	1.0X10 ¹	2.7X10 ²	2.0X10 ⁻²	5.3X10 ⁻³
Lu-177	.	3.0X10 ¹	8.1X10 ²	7.0X10 ⁻¹	1.9X10 ¹	4.1X10 ⁻³	1.1X10 ⁻⁵
Mg-28.(a)	Magnesium.(12)	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	2.0X10 ⁻⁵	5.4X10 ⁻⁶
Mn-52	Manganese.(25)	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.6X10 ⁻⁴	4.4X10 ⁻⁵
Mn-53	.	Unlimited	Unlimited	Unlimited	Unlimited	6.8X10 ⁻⁵	1.8X10 ⁻³
Mn-54	.	1.0	2.7X10 ¹	1.0	2.7X10 ¹	2.9X10 ⁻²	7.7X10 ⁻³
Mn-56	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	8.0X10 ⁻⁵	2.2X10 ⁻⁷
Mo-93	Molybdenum.(42)	4.0X10 ¹	1.1X10 ³	2.0X10 ¹	5.4X10 ²	4.1X10 ⁻²	1.1
Mo-99.(a).(i)	.	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.8X10 ⁻⁴	4.8X10 ⁻⁵
N-13	Nitrogen.(7)	9.0X1	2.4X1	6.0X1	1.6X1	5.4X10 ⁻⁷	1.5X10 ⁻⁹

Document #10

RQ

DRAFT 1 04/02/14

	)	0^{-1}	0^1	0^{-1}	0^1		
Na-22	Sodium.(11)	$5.0X10^{-1}$	$1.4X10^1$	$5.0X10^{-1}$	$1.4X10^1$	$2.3X10^{-2}$	$6.3X10^{-3}$
Na-24	.	$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$3.2X10^{-5}$	$8.7X10^{-6}$
Nb-93m	Niobium.(41)	$4.0X10^1$	$1.1X10^3$	$3.0X10^1$	$8.1X10^2$	8.8	$2.4X10^{-2}$
Nb-94	.	$7.0X10^{-1}$	$1.9X10^1$	$7.0X10^{-1}$	$1.9X10^1$	$6.9X10^{-3}$	$1.9X10^{-1}$
Nb-95	.	1.0	$2.7X10^1$	1.0	$2.7X10^1$	$1.5X10^{-3}$	$3.9X10^{-4}$
Nb-97	.	$9.0X10^{-1}$	$2.4X10^1$	$6.0X10^{-1}$	$1.6X10^1$	$9.9X10^{-5}$	$2.7X10^{-7}$
Nd-147	Neodymium.(60)	6.0	$1.6X10^2$	$6.0X10^{-1}$	$1.6X10^1$	$3.0X10^{-3}$	$8.1X10^{-4}$
Nd-149	.	$6.0X10^{-1}$	$1.6X10^1$	$5.0X10^{-1}$	$1.4X10^1$	$4.5X10^{-5}$	$1.2X10^{-7}$
Ni-59	Nickel.(28)	Unlimited	Unlimited	Unlimited	Unlimited	$3.0X10^{-3}$	$8.0X10^{-2}$
Ni-63	.	$4.0X10^1$	$1.1X10^3$	$3.0X10^1$	$8.1X10^2$	2.1	$5.7X10^{-1}$
Ni-65	.	$4.0X10^{-1}$	$1.1X10^1$	$4.0X10^{-1}$	$1.1X10^1$	$7.1X10^{-5}$	$1.9X10^{-7}$
Np-235	Neptunium.(93)	$4.0X10^1$	$1.1X10^3$	$4.0X10^1$	$1.1X10^3$	$5.2X10^{-1}$	$1.4X10^{-3}$
Np-236. (short-lived)	.	$2.0X10^1$	$5.4X10^2$	2.0	$5.4X10^1$	$4.7X10^{-4}$	$1.3X10^{-2}$
Np-236. (long-lived)	.	$9.0X10^0$	$2.4X10^2$	$2.0X10^{-2}$	$5.4X10^{-1}$	$4.7X10^{-4}$	$1.3X10^{-2}$
Np-237	.	$2.0X10^1$	$5.4X10^2$	$2.0X10^{-3}$	$5.4X10^{-2}$	$2.6X10^{-5}$	$7.1X10^{-4}$
Np-239	.	7.0	$1.9X10^2$	$4.0X10^{-1}$	$1.1X10^1$	$8.6X10^{-3}$	$2.3X10^{-5}$
Os-185	Osmium.(76)	1.0	$2.7X10^1$	1.0	$2.7X10^1$	$2.8X10^{-2}$	$7.5X10^{-3}$
Os-191	.	$1.0X10^1$	$2.7X10^2$	2.0	$5.4X10^1$	$1.6X10^{-3}$	$4.4X10^{-4}$
Os-191m	.	$4.0X10^1$	$1.1X10^3$	$3.0X10^1$	$8.1X10^2$	$4.6X10^{-4}$	$1.3X10^{-6}$
Os-193	.	2.0	$5.4X10^1$	$6.0X10^{-1}$	$1.6X10^1$	$2.0X10^{-4}$	$5.3X10^{-5}$
Os-	.	$3.0X10^1$	8.1	$3.0X10^1$	8.1	$1.1X10^{-1}$	$3.1X10^{-2}$

Document #10

RQ

DRAFT 1 04/02/14

194.(a)		0 ⁻¹		0 ⁻¹			
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724

725

TABLE 17A1: A₁ AND A₂ VALUES FOR RADIONUCLIDES – Part 3 of 4

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (Tab)	A ₂ (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
P-32	Phosphorus (15)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	1.1X10 ⁻⁴	2.9X10 ⁻⁵
P-33	.	4.0X10 ¹	1.1X10 ³	1.0	2.7X10 ¹	5.8X10 ⁻³	1.6X10 ⁻⁵
Pa-230 (a)	Protactinium (91)	2.0	5.4X10 ¹	7.0X10 ⁻²	1.9	1.2X10 ⁻³	3.3X10 ⁻⁴
Pa-231	.	4.0	1.1X10 ²	4.0X10 ⁻⁴	1.1X10 ⁻²	1.7X10 ⁻³	4.7X10 ⁻²
Pa-233	.	5.0	1.4X10 ²	7.0X10 ⁻¹	1.9X10 ¹	7.7X10 ⁻²	2.1X10 ⁻⁴
Pb-201	Lead (82)	1.0	2.7X10 ¹	1.0	2.7X10 ¹	6.2X10 ⁻⁴	1.7X10 ⁻⁶
Pb-202	.	4.0X10 ¹	1.1X10 ³	2.0X10 ¹	5.4X10 ²	1.2X10 ⁻⁴	3.4X10 ⁻³
Pb-203	.	4.0	1.1X10 ²	3.0	8.1X10 ¹	1.1X10 ⁻⁴	3.0X10 ⁻⁵
Pb-205	.	Unlimited	Unlimited	Unlimited	Unlimited	4.5X10 ⁻⁶	1.2X10 ⁻⁴
Pb-210 (a)	.	1.0	2.7X10 ¹	5.0X10 ⁻²	1.4	2.8	7.6X10 ⁻¹
Pb-212 (a)	.	7.0X10 ⁻¹	1.9X10 ¹	2.0X10 ⁻¹	5.4	5.1X10 ⁻⁴	1.4X10 ⁻⁶
Pd-103 (a)	Palladium (46)	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	2.8X10 ⁻³	7.5X10 ⁻⁴
Pd-107	.	Unlimited	Unlimited	Unlimited	Unlimited	1.9X10 ⁻⁵	5.1X10 ⁻⁴
Pd-109	.	2.0	5.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	7.9X10 ⁻⁴	2.1X10 ⁻⁶
Pm-143	Promethium (61)	3.0	8.1X10 ¹	3.0	8.1X10 ¹	1.3X10 ⁻²	3.4X10 ⁻³
Pm-144	.	7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	9.2X10 ⁻¹	2.5X10 ⁻³
Pm-145	.	3.0X10 ¹	8.1X10 ²	1.0X10 ¹	2.7X10 ²	5.2	1.4X10 ⁻²
Pm-147	.	4.0X1	1.1X1	2.0	5.4X1	3.4X10 ⁻¹	9.3X10 ⁻²

Document #10

RQ

DRAFT 1 04/02/14

		0^1	0^3		0^1		
Pm-148m . (a)	.	$8.0X10^{-1}$	$2.2X10^1$	$7.0X10^{-1}$	$1.9X10^1$	$7.9X10^2$	$2.1X10^4$
Pm-149	.	2.0	$5.4X10^1$	$6.0X10^{-1}$	$1.6X10^1$	$1.5X10^4$	$4.0X10^5$
Pm-151	.	2.0	$5.4X10^1$	$6.0X10^{-1}$	$1.6X10^1$	$2.7X10^4$	$7.3X10^5$
Po-210	Polonium . (84)	$4.0X10^1$	$1.1X10^3$	$2.0X10^{-2}$	$5.4X10^{-1}$	$1.7X10^2$	$4.5X10^3$
Pr-142	Praseodymium . (59)	$4.0X10^{-1}$	$1.1X10^1$	$4.0X10^{-1}$	$1.1X10^1$	$4.3X10^4$	$1.2X10^6$
Pr-143	.	3.0	$8.1X10^1$	$6.0X10^{-1}$	$1.6X10^1$	$2.5X10^3$	$6.7X10^4$
Pt-188 . (a)	Platinum . (78)	1.0	$2.7X10^1$	$8.0X10^{-1}$	$2.2X10^1$	$2.5X10^3$	$6.8X10^4$
Pt-191	.	4.0	$1.1X10^2$	3.0	$8.1X10^1$	$8.7X10^3$	$2.4X10^5$
Pt-193	.	$4.0X10^1$	$1.1X10^3$	$4.0X10^1$	$1.1X10^3$	1.4	$3.7X10^1$
Pt-193m	.	$4.0X10^1$	$1.1X10^3$	$5.0X10^{-1}$	$1.4X10^1$	$5.8X10^3$	$1.6X10^5$
Pt-195m	.	$1.0X10^1$	$2.7X10^2$	$5.0X10^{-1}$	$1.4X10^1$	$6.2X10^3$	$1.7X10^5$
Pt-197	.	$2.0X10^1$	$5.4X10^2$	$6.0X10^{-1}$	$1.6X10^1$	$3.2X10^4$	$8.7X10^5$
Pt-197m	.	$1.0X10^1$	$2.7X10^2$	$6.0X10^{-1}$	$1.6X10^1$	$3.7X10^5$	$1.0X10^7$
Pu-236	Plutonium . (94)	$3.0X10^1$	$8.1X10^2$	$3.0X10^{-3}$	$8.1X10^{-2}$	$2.0X10^1$	$5.3X10^2$
Pu-237	.	$2.0X10^1$	$5.4X10^2$	$2.0X10^1$	$5.4X10^2$	$4.5X10^2$	$1.2X10^4$
Pu-238	.	$1.0X10^1$	$2.7X10^2$	$1.0X10^{-3}$	$2.7X10^{-2}$	$6.3X10^{-1}$	$1.7X10^1$
Pu-239	.	$1.0X10^1$	$2.7X10^2$	$1.0X10^{-3}$	$2.7X10^{-2}$	$2.3X10^{-3}$	$6.2X10^{-2}$
Pu-240	.	$1.0X10^1$	$2.7X10^2$	$1.0X10^{-3}$	$2.7X10^{-2}$	$8.4X10^{-3}$	$2.3X10^{-1}$
Pu-241 . (a)	.	$4.0X10^1$	$1.1X10^3$	$6.0X10^{-2}$	1.6	3.8	$1.0X10^2$
Pu-242	.	$1.0X10^1$	$2.7X10^2$	$1.0X10^{-3}$	$2.7X10^{-2}$	$1.5X10^{-4}$	$3.9X10^{-3}$
Pu-244 .	.	$4.0X10^1$	$1.1X10^1$	$1.0X10^1$	$2.7X10^1$	$6.7X10^{-7}$	$1.8X10^{-5}$

Document #10

RQ

DRAFT 1 04/02/14

(a)		0^{-1}	0^1	0^{-3}	0^{-2}		
Ra-223 . (a)	Radium . (88)	$4.0X10^{-1}$	$1.1X10^1$	$7.0X10^{-3}$	$1.9X10^{-1}$	$1.9X10^{-3}$	$5.1X10^{-4}$
Ra-224 . (a)	.	$4.0X10^{-1}$	$1.1X10^1$	$2.0X10^{-2}$	$5.4X10^{-1}$	$5.9X10^{-3}$	$1.6X10^{-5}$
Ra-225 . (a)	.	$2.0X10^{-1}$	5.4	$4.0X10^{-3}$	$1.1X10^{-1}$	$1.5X10^{-3}$	$3.9X10^{-4}$
Ra-226 . (a)	.	$2.0X10^{-1}$	5.4	$3.0X10^{-3}$	$8.1X10^{-2}$	$3.7X10^{-2}$	1.0
Ra-228 . (a)	.	$6.0X10^{-1}$	$1.6X10^1$	$2.0X10^{-2}$	$5.4X10^{-1}$	$1.0X10^1$	$2.7X10^{-2}$
Rb-81	Rubidium . (37)	2.0	$5.4X10^1$	$8.0X10^{-1}$	$2.2X10^1$	$3.1X10^{-5}$	$8.4X10^{-6}$
Rb-83 . (a)	.	2.0	$5.4X10^1$	2.0	$5.4X10^1$	$6.8X10^{-2}$	$1.8X10^{-4}$
Rb-84	.	1.0	$2.7X10^1$	1.0	$2.7X10^1$	$1.8X10^{-3}$	$4.7X10^{-4}$
Rb-86	.	$5.0X10^{-1}$	$1.4X10^1$	$5.0X10^{-1}$	$1.4X10^1$	$3.0X10^{-3}$	$8.1X10^{-4}$
Rb-87	.	Unlimited	Unlimited	Unlimited	Unlimited	$3.2X10^{-9}$	$8.6X10^{-8}$
Rb(nat)	.	Unlimited	Unlimited	Unlimited	Unlimited	$6.7X10^{-6}$	$1.8X10^{-8}$
Re-184	Rhenium . (75)	1.0	$2.7X10^1$	1.0	$2.7X10^1$	$6.9X10^{-2}$	$1.9X10^{-4}$
Re-184m	.	3.0	$8.1X10^1$	1.0	$2.7X10^1$	$1.6X10^{-2}$	$4.3X10^{-3}$
Re-186	.	2.0	$5.4X10^1$	$6.0X10^{-1}$	$1.6X10^1$	$6.9X10^{-3}$	$1.9X10^{-5}$
Re-187	.	Unlimited	Unlimited	Unlimited	Unlimited	$1.4X10^{-9}$	$3.8X10^{-8}$
Re-188	.	$4.0X10^{-1}$	$1.1X10^1$	$4.0X10^{-1}$	$1.1X10^1$	$3.6X10^{-4}$	$9.8X10^{-5}$
Re-189 . (a)	.	3.0	$8.1X10^1$	$6.0X10^{-1}$	$1.6X10^1$	$2.5X10^{-4}$	$6.8X10^{-5}$
Re(nat)	.	Unlimited	Unlimited	Unlimited	Unlimited	0.0	$2.4X10^{-8}$
Rh-99	Rhodium . (45)	2.0	$5.4X10^1$	2.0	$5.4X10^1$	$3.0X10^{-3}$	$8.2X10^{-4}$
Rh-101	.	4.0	$1.1X10^2$	3.0	$8.1X10^1$	$4.1X10^1$	$1.1X10^{-3}$
Rh-102	.	$5.0X10^{-1}$	$1.4X10^1$	$5.0X10^{-1}$	$1.4X10^1$	$4.5X10^1$	$1.2X10^{-3}$

Document #10

RQ

DRAFT 1 04/02/14

Rh-102m	.	2.0	5.4X10 ¹	2.0	5.4X10 ¹	2.3X10 ²	6.2X10 ³
Rh-103m	.	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	1.2X10 ⁶	3.3X10 ⁷
Rh-105	.	1.0X10 ¹	2.7X10 ²	8.0X10 ⁻¹	2.2X10 ¹	3.1X10 ⁴	8.4X10 ⁵
Rn-222 . (a)	Radon . (86)	3.0X10 ⁻¹	8.1	4.0X10 ⁻³	1.1X10 ⁻¹	5.7X10 ³	1.5X10 ⁵
Ru-97	Ruthenium . m . (44)	5.0	1.4X10 ²	5.0	1.4X10 ²	1.7X10 ⁴	4.6X10 ⁵
Ru-103 . (a)	.	2.0	5.4X10 ¹	2.0	5.4X10 ¹	1.2X10 ³	3.2X10 ⁴
Ru-105	.	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.5X10 ⁵	6.7X10 ⁶
Ru-106 . (a)	.	2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	1.2X10 ²	3.3X10 ³
S-35	Sulphur . (16)	4.0X10 ¹	1.1X10 ³	3.0	8.1X10 ¹	1.6X10 ³	4.3X10 ⁴
Sb-122	Antimony . (51)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.5X10 ⁴	4.0X10 ⁵
Sb-124	.	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	6.5X10 ²	1.7X10 ⁴
Sb-125	.	2.0	5.4X10 ¹	1.0	2.7X10 ¹	3.9X10 ¹	1.0X10 ³
Sb-126	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	3.1X10 ³	8.4X10 ⁴
Sc-44	Scandium . (21)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	6.7X10 ⁵	1.8X10 ⁷
Sc-46	.	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	1.3X10 ³	3.4X10 ⁴
Sc-47	.	1.0X10 ¹	2.7X10 ²	7.0X10 ⁻¹	1.9X10 ¹	3.1X10 ⁴	8.3X10 ⁵
Sc-48	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	5.5X10 ⁴	1.5X10 ⁶
Se-75	Selenium . (34)	3.0	8.1X10 ¹	3.0	8.1X10 ¹	5.4X10 ²	1.5X10 ⁴
Se-79	.	4.0X10 ¹	1.1X10 ³	2.0	5.4X10 ¹	2.6X10 ⁻³	7.0X10 ⁻²
Si-31	Silicon . (14)	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.4X10 ⁶	3.9X10 ⁷
Si-32	.	4.0X10 ¹	1.1X10 ³	5.0X10 ⁻¹	1.4X10 ¹	3.9	1.1X10 ²
Sm-145	Samarium . (62)	1.0X10 ¹	2.7X10 ²	1.0X10 ¹	2.7X10 ²	9.8X10 ¹	2.6X10 ³

Document #10

RQ

DRAFT 1 04/02/14

Sm-147	.	Unlimited	Unlimited	Unlimited	Unlimited	8.5×10^{-1}	2.3×10^{-8}
Sm-151	.	4.0×10^1	1.1×10^3	1.0×10^1	2.7×10^2	9.7×10^{-1}	2.6×10^1
Sm-153	.	9.0	2.4×10^2	6.0×10^{-1}	1.6×10^1	1.6×10^4	4.4×10^5
Sn-113 (a)	Tin . (50)	4.0	1.1×10^2	2.0	5.4×10^1	3.7×10^2	1.0×10^4
Sn-117m	.	7.0	1.9×10^2	4.0×10^{-1}	1.1×10^1	3.0×10^3	8.2×10^4
Sn-119m	.	4.0×10^1	1.1×10^3	3.0×10^1	8.1×10^2	1.4×10^2	3.7×10^3
Sn-121m (a)	.	4.0×10^1	1.1×10^3	9.0×10^{-1}	2.4×10^1	2.0	5.4×10^1
Sn-123	.	8.0×10^{-1}	2.2×10^1	6.0×10^{-1}	1.6×10^1	3.0×10^2	8.2×10^3
Sn-125	.	4.0×10^{-1}	1.1×10^1	4.0×10^{-1}	1.1×10^1	4.0×10^3	1.1×10^5
Sn-126 (a)	.	6.0×10^{-1}	1.6×10^1	4.0×10^{-1}	1.1×10^1	1.0×10^{-3}	2.8×10^{-2}
Sr-82 (a)	Strontium . (38)	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4	2.3×10^3	6.2×10^4
Sr-85	.	2.0	5.4×10^1	2.0	5.4×10^1	8.8×10^2	2.4×10^4
Sr-85m	.	5.0	1.4×10^2	5.0	1.4×10^2	1.2×10^6	3.3×10^7
Sr-87m	.	3.0	8.1×10^1	3.0	8.1×10^1	4.8×10^5	1.3×10^7

726

727

TABLE 17A1: A₁ AND A₂ VALUES FOR RADIONUCLIDES – Part 4 of 4

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (Tab)	A ₂ (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Sr-89	.	6.0×10^{-1}	1.6×10^1	6.0×10^{-1}	1.6×10^1	1.1×10^3	2.9×10^4
Sr-90 (a)	.	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1	5.1	1.4×10^2
Sr-91 (a)	.	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1	1.3×10^5	3.6×10^6

Document #10

RQ

DRAFT 1 04/02/14

Sr-92 . (a)	.	1.0	2.7X10 ₁	3.0X10 ₋₁	8.1	4.7X10 ⁵	1.3X10 ⁷
T(H-3)	Tritium . (1)	4.0X10 ₁	1.1X10 ₃	4.0X10 ₁	1.1X10 ₃	3.6X10 ²	9.7X10 ³
Ta-178 . (long)	Tantalum . (73)	1.0	2.7X10 ₁	8.0X10 ₋₁	2.2X10 ₁	4.2X10 ⁶	1.1X10 ⁸
Ta-179	.	3.0X10 ₁	8.1X10 ₂	3.0X10 ₁	8.1X10 ₂	4.1X10 ¹	1.1X10 ³
Ta-182	.	9.0X10 ₋₁	2.4X10 ₁	5.0X10 ₋₁	1.4X10 ₁	2.3X10 ²	6.2X10 ³
Tb-157	Terbium . (65)	4.0X10 ₁	1.1X10 ₃	4.0X10 ₁	1.1X10 ₃	5.6X10 ⁻¹	1.5X10 ¹
Tb-158	.	1.0	2.7X10 ₁	1.0	2.7X10 ₁	5.6X10 ⁻¹	1.5X10 ¹
Tb-160	.	1.0	2.7X10 ₁	6.0X10 ₋₁	1.6X10 ₁	4.2X10 ²	1.1X10 ⁴
Tc-95m . (a)	Technetium . (43)	2.0	5.4X10 ₁	2.0	5.4X10 ₁	8.3X10 ²	2.2X10 ⁴
Tc-96	.	4.0X10 ₋₁	1.1X10 ₁	4.0X10 ₋₁	1.1X10 ₁	1.2X10 ⁴	3.2X10 ⁵
Tc-96m . (a)	.	4.0X10 ₋₁	1.1X10 ₁	4.0X10 ₋₁	1.1X10 ₁	1.4X10 ⁶	3.8X10 ⁷
Tc-97	.	Unlimit ed	Unlimit ed	Unlimit ed	Unlimit ed	5.2X10 ⁻⁵	1.4X10 ⁻³
Tc-97m	.	4.0X10 ₁	1.1X10 ₃	1.0	2.7X10 ₁	5.6X10 ²	1.5X10 ⁴
Tc-98	.	8.0X10 ₋₁	2.2X10 ₁	7.0X10 ₋₁	1.9X10 ₁	3.2X10 ⁻⁵	8.7X10 ⁻⁴
Tc-99	.	4.0X10 ₁	1.1X10 ₃	9.0X10 ₋₁	2.4X10 ₁	6.3X10 ⁻⁴	1.7X10 ⁻²
Tc-99m	.	1.0X10 ₁	2.7X10 ₂	4.0	1.1X10 ₂	1.9X10 ⁵	5.3X10 ⁶
Te-121	Tellurium . (52)	2.0	5.4X10 ₁	2.0	5.4X10 ₁	2.4X10 ³	6.4X10 ⁴
Te-121m	.	5.0	1.4X10 ₂	3.0	8.1X10 ₁	2.6X10 ²	7.0X10 ³
Te-123m	.	8.0	2.2X10 ₂	1.0	2.7X10 ₁	3.3X10 ²	8.9X10 ³
Te-125m	.	2.0X10 ₁	5.4X10 ₂	9.0X10 ₋₁	2.4X10 ₁	6.7X10 ²	1.8X10 ⁴
Te-127	.	2.0X10 ₁	5.4X10 ₂	7.0X10 ₋₁	1.9X10 ₁	9.8X10 ⁴	2.6X10 ⁶
Te-127m . (a)	.	2.0X10 ₁	5.4X10 ₂	5.0X10 ₋₁	1.4X10 ₁	3.5X10 ²	9.4X10 ³

Document #10

RQ

DRAFT 1 04/02/14

Te-129	.	7.0X10 ⁻¹	1.9X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	7.7X10 ^{0⁵}	2.1X10 ^{0⁷}
Te-129m . (a)	.	8.0X10 ⁻¹	2.2X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.1X10 ^{0³}	3.0X10 ^{0⁴}
Te-131m . (a)	.	7.0X10 ⁻¹	1.9X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	3.0X10 ^{0⁴}	8.0X10 ^{0⁵}
Te-132 . (a)	.	5.0X10 ⁻¹	1.4X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	3.1X10 ^{0⁴}	3.0X10 ^{0⁵}
Th-227	Thorium . (90)	1.0X10 ¹	2.7X10 ²	5.0X10 ⁻³	1.4X10 ⁻¹	1.1X10 ^{0³}	3.1X10 ^{0⁴}
Th-228 . (a)	.	5.0X10 ⁻¹	1.4X10 ¹	1.0X10 ⁻³	2.7X10 ⁻²	3.0X10 ^{0¹}	8.2X10 ^{0²}
Th-229	.	5.0	1.4X10 ²	5.0X10 ⁻⁴	1.4X10 ⁻²	7.9X10 ^{0⁻³}	2.1X10 ^{0⁻¹}
Th-230	.	1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	7.6X10 ^{0⁻⁴}	2.1X10 ^{0⁻²}
Th-231	.	4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	2.0X10 ^{0⁴}	5.3X10 ^{0⁵}
Th-232	.	Unlimit ed	Unlimit ed	Unlimit ed	Unlimit ed	4.0X10 ^{0⁻⁹}	1.1X10 ^{0⁻⁷}
Th-234 . (a)	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	8.6X10 ^{0²}	2.3X10 ^{0⁴}
Th(nat)	.	Unlimit ed	Unlimit ed	Unlimit ed	Unlimit ed	8.1X10 ^{0⁻⁹}	2.2X10 ^{0⁻⁷}
Ti-44 . (a)	Titanium . (22)	5.0X10 ⁻¹	1.4X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	6.4	1.7X10 ^{0²}
Tl-200	Thallium . (81)	9.0X10 ⁻¹	2.4X10 ¹	9.0X10 ⁻¹	2.4X10 ¹	2.2X10 ^{0⁴}	6.0X10 ^{0⁵}
Tl-201	.	1.0X10 ¹	2.7X10 ²	4.0	1.1X10 ²	7.9X10 ^{0³}	2.1X10 ^{0⁵}
Tl-202	.	2.0	5.4X10 ¹	2.0	5.4X10 ¹	2.0X10 ^{0³}	5.3X10 ^{0⁴}
Tl-204	.	1.0X10 ¹	2.7X10 ²	7.0X10 ⁻¹	1.9X10 ¹	1.7X10 ^{0¹}	4.6X10 ^{0²}
Tm-167	Thulium . (69)	7.0	1.9X10 ²	8.0X10 ⁻¹	2.2X10 ¹	3.1X10 ^{0³}	8.5X10 ^{0⁴}
Tm-170	.	3.0	8.1X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.2X10 ^{0²}	6.0X10 ^{0³}
Tm-171	.	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	4.0X10 ^{0¹}	1.1X10 ^{0³}
U-230 . (fast . lung . absorption	Uranium . (92)	4.0X10 ¹	1.1X10 ³	1.0X10 ⁻¹	2.7	1.0X10 ^{0³}	2.7X10 ^{0⁴}

Comment [JJ22]: The change is necessary for compatibility with equivalent NRC requirements in 10 CFR Part 71, Table A-1.

Compatibility = B
NRC RATS = 2012-3

Document #10

RQ

DRAFT 1 04/02/14

. (a)(d)	.	4.0×10^1	1.1×10^3	4.0×10^{-3}	1.1×10^{-1}	1.0×10^3	2.7×10^4
U-230 . (medium . lung . absorption) . (a)(e)	.	3.0×10^1	8.1×10^2	3.0×10^{-3}	8.1×10^{-2}	1.0×10^3	2.7×10^4
U-230 . (slow . lung . absorption) . (a)(f)	.	4.0×10^1	1.1×10^3	1.0×10^{-2}	2.7×10^{-1}	8.3×10^0	2.2×10^1
U-232 . (fast . lung . absorption) . (d)	.	4.0×10^1	1.1×10^3	7.0×10^{-3}	1.9×10^{-1}	8.3×10^0	2.2×10^1
U-232 . (medium . lung . absorption) . (e)	.	1.0×10^1	2.7×10^2	1.0×10^{-3}	2.7×10^{-2}	8.3×10^0	2.2×10^1
U-232 . (slow . lung . absorption) . (f)	.	4.0×10^1	1.1×10^3	9.0×10^{-2}	2.4	3.6×10^0	9.7×10^{-3}
U-233 . (fast . lung . absorption) . (d)	.	4.0×10^1	1.1×10^3	2.0×10^{-2}	5.4×10^{-1}	3.6×10^0	9.7×10^{-3}
U-233 . (medium . lung . absorption) . (e)	.	4.0×10^1	1.1×10^3	6.0×10^{-3}	1.6×10^{-1}	3.6×10^0	9.7×10^{-3}
U-233 . (slow . lung . absorption) . (f)	.	4.0×10^1	1.1×10^3	9.0×10^{-2}	2.4	2.3×10^0	6.2×10^{-3}
U-234 . (fast . lung . absorption) . (d)	.	4.0×10^1	1.1×10^3	9.0×10^{-2}	2.4	2.3×10^0	6.2×10^{-3}

Document #10

RQ

DRAFT 1 04/02/14

. (d)							
U-234 . (medium . lung . absorption) . (e)	.	4.0X10 ₁	1.1X10 ₃	2.0X10 ₋₂	5.4X10 ₋₁	2.3X10 _{0⁻⁴}	6.2X10 _{0⁻³}
U-234 . (slow . lung . absorption) . (f)	.	4.0X10 ₁	1.1X10 ₃	6.0X10 ₋₃	1.6X10 ₋₁	2.3X10 _{0⁻⁴}	6.2X10 _{0⁻³}
U-235 . (all . lung absorption types) . (a),(d),(e), (f)	.	Unlimit ed	Unlimit ed	Unlimit ed	Unlimit ed	8.0X10 _{0⁻⁸}	2.2X10 _{0⁻⁶}
U-236 . (fast . lung . absorption) . (d)	.	Unlimit ed	Unlimit ed	Unlimit ed	Unlimit ed	2.4X10 _{0⁻⁶}	6.5X10 _{0⁻⁵}
U-236 . (medium . lung . absorption) . (e)	.	4.0X10 ₁	1.1X10 ₃	2.0X10 ₋₂	5.4X10 ₋₁	2.4X10 _{0⁻⁶}	6.5X10 _{0⁻⁵}
U-236 . (slow . lung . absorption) . (f)	.	4.0X10 ₁	1.1X10 ₃	6.0X10 ₋₃	1.6X10 ₋₁	2.4X10 _{0⁻⁶}	6.5X10 _{0⁻⁵}
U-238 . (all . lung absorption types) . (d),(e),(f)	.	Unlimit ed	Unlimit ed	Unlimit ed	Unlimit ed	1.2X10 _{0⁻⁸}	3.4X10 _{0⁻⁷}
U . (nat)	.	Unlimit ed	Unlimit ed	Unlimit ed	Unlimit ed	2.6X10 _{0⁻⁸}	7.1X10 _{0⁻⁷}
U . (enriched to . 20% . or .	.	Unlimit ed	Unlimit ed	Unlimit ed	Unlimit ed	See . Table . 17A-4	See . Table . 17A-4

Comment [JJ23]: Correction of reference to appropriate table.

Document #10

RQ

DRAFT 1 04/02/14

less) . (g)							
U . (dep)	.	Unlimit ed	Unlimit ed	Unlimit ed	Unlimit ed	See Table . 17A-4	(See Table . 17A- 3)
V-48	Vanadium . (23)	4.0X10 ⁻¹	1.1X10 ₁	4.0X10 ⁻¹	1.1X10 ₁	6.3X10 ³	1.7X10 ⁵
V-49	.	4.0X10 ₁	1.1X10 ₃	4.0X10 ₁	1.1X10 ₃	3.0X10 ²	8.1X10 ³
W-178 . (a)	Tungsten . (74)	9.0	2.4X10 ₂	5.0	1.4X10 ₂	1.3X10 ³	3.4X10 ⁴
W-181	.	3.0X10 ₁	8.1X10 ₂	3.0X10 ₁	8.1X10 ₂	2.2X10 ²	6.0X10 ³
W-185	.	4.0X10 ₁	1.1X10 ₃	8.0X10 ⁻¹	2.2X10 ₁	3.5X10 ²	9.4X10 ³
W-187	.	2.0	5.4X10 ₁	6.0X10 ⁻¹	1.6X10 ₁	2.6X10 ⁴	7.0X10 ⁵
W-188 . (a)	.	4.0X10 ⁻¹	1.1X10 ₁	3.0X10 ⁻¹	8.1	3.7X10 ²	1.0X10 ⁴
Xe-122 . (a)	Xenon . (54)	4.0X10 ⁻¹	1.1X10 ₁	4.0X10 ⁻¹	1.1X10 ₁	4.8X10 ⁴	1.3X10 ⁶
Xe-123	.	2.0	5.4X10 ₁	7.0X10 ⁻¹	1.9X10 ₁	4.4X10 ⁵	1.2X10 ⁷
Xe-127	.	4.0	1.1X10 ₂	2.0	5.4X10 ₁	1.0X10 ³	2.8X10 ⁴
Xe-131m	.	4.0X10 ₁	1.1X10 ₃	4.0X10 ₁	1.1X10 ₃	3.1X10 ³	8.4X10 ⁴
Xe-133	.	2.0X10 ₁	5.4X10 ₂	1.0X10 ₁	2.7X10 ₂	6.9X10 ³	1.9X10 ⁵
Xe-135	.	3.0	8.1X10 ₁	2.0	5.4X10 ₁	9.5X10 ⁴	2.6X10 ⁶
Y-87 . (a)	Yttrium . (39)	1.0	2.7X10 ₁	1.0	2.7X10 ₁	1.7X10 ⁴	4.5X10 ⁵
Y-88	.	4.0X10 ⁻¹	1.1X10 ₁	4.0X10 ⁻¹	1.1X10 ₁	5.2X10 ²	1.4X10 ⁴
Y-90	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	2.0X10 ⁴	5.4X10 ⁵
Y-91	.	6.0X10 ⁻¹	1.6X10 ₁	6.0X10 ⁻¹	1.6X10 ₁	9.1X10 ²	2.5X10 ⁴
Y-91m	.	2.0	5.4X10 ₁	2.0	5.4X10 ₁	1.5X10 ⁶	4.2X10 ⁷
Y-92	.	2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	3.6X10 ⁵	9.6X10 ⁶
Y-93	.	3.0X10	8.1	3.0X10	8.1	1.2X1	3.3X1

Comment [JJ24]: Correction of reference to appropriate table.

Document #10

RQ

DRAFT 1 04/02/14

		-1		-1		0 ⁵	0 ⁶
Yb-169	Ytterbium . (70)	4.0	1.1X10 ₂	1.0	2.7X10 ₁	8.9X10 _{0²}	2.4X10 _{0⁴}
Yb-175	.	3.0X10 ₁	8.1X10 ₂	9.0X10 ₋₁	2.4X10 ₁	6.6X10 _{0³}	1.8X10 _{0⁵}
Zn-65	Zinc . (30)	2.0	5.4X10 ₁	2.0	5.4X10 ₁	3.0X10 _{0²}	8.2X10 _{0³}
Zn-69	.	3.0	8.1X10 ₁	6.0X10 ₋₁	1.6X10 ₁	1.8X10 _{0⁶}	4.9X10 _{0⁷}
Zn-69m . (a)	.	3.0	8.1X10 ₁	6.0X10 ₋₁	1.6X10 ₁	1.2X10 _{0⁵}	3.3X10 _{0⁶}
Zr-88	Zirconium . (40)	3.0	8.1X10 ₁	3.0	8.1X10 ₁	6.6X10 _{0²}	1.8X10 _{0⁴}
Zr-93	.	Unlimit ed	Unlimit ed	Unlimit ed	Unlimit ed	9.3X10 _{0⁻⁵}	2.5X10 _{0⁻³}
Zr-95 . (a)	.	2.0	5.4X10 ₁	8.0X10 ₋₁	2.2X10 ₁	7.9X10 _{0²}	2.1X10 _{0⁴}
Zr-97 . (a)	.	4.0X10 ₋₁	1.1X10 ₁	4.0X10 ₋₁	1.1X10 ₁	7.1X10 _{0⁴}	1.9X10 _{0⁶}

728

729

Notes:

730

a A1 and/or A2 values include contributions from daughter nuclides with half-lives less than 10 days.

731

b The values of A₁ and A₂ in Curies (Ci) are approximate and for information only; the regulatory standard units are Terabecquerels (TBq) (see Appendix 17A – Determination of A₁ and A₂, Section 17A1)

732

~~b Parent nuclides and their progeny included in secular equilibrium are listed in the following:~~

733

~~Sr-90 — Y-90~~

734

~~Zr-93 — Nb-93m~~

735

~~Zr-97 — Nb-97~~

736

~~Ru-106 — Rh-106~~

737

~~Ce-137 — Ba-137m~~

738

~~Ce-134 — La-134~~

739

~~Ce-144 — Pr-144~~

740

~~Ba-140 — La-140~~

741

~~Bi-212 — Tl-208 0.36 , Po-212 0.64~~

742

~~Pb-210 — Bi-210, Po-210~~

743

~~Pb-212 — Bi-212, Tl-208 0.36 , Po-212 0.64~~

744

~~Rn-220 — Po-216~~

745

~~Rn-222 — Po-218, Pb-214, Bi-214, Po-214~~

746

~~Ra-223 — Rn-219, Po-215, Pb-211, Bi-211, Tl-207~~

747

~~Ra-224 — Rn-220, Po-216, Pb-212, Bi-212, Tl-208 0.36 , Po-212 0.64~~

748

~~Ra-226 — Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210~~

749

~~Ra-228 — Ac-228~~

750

~~Th-226 — Ra-222, Rn-218, Po-214~~

751

Comment [JJ25]: The new footnote “b” is added, consistent with 10 CFR 71, Appendix A, Table A-1.

The added footnote effectively restates the information contained in the introductory text of Section 17A1.

NRC Compatibility = [B]
NRC RATS = 2012-3

Comment [JJ26]: Footnote “b” is deleted here and relocated to Table 17A2. The original reference here was incorrect as there are no items in Table 17A1 originally referenced this footnote.

The approach here is consistent with the footnotes of 10 CFR 71, Appendix A, Table A-1.

Document #10

RQ

DRAFT 1 04/02/14

- 752 ~~Th-228 — Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 0.36, Po-212 0.64~~
- 753 ~~Th-229 — Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209~~
- 754 ~~Th-nat — Ra-228, Ac-228, Th-232, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 0.36, Po-12 0.64~~
- 755 ~~Th-234 — Pa-234m~~
- 756 ~~U-230 — Th-226, Ra-222, Rn-218, Po-214~~
- 757 ~~U-232 — Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 0.36, Po-212 0.64~~
- 758 ~~U-235 — Th-231~~
- 759 ~~U-238 — Th-234, Pa-234m~~
- 760 ~~U-nat — Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214,~~
- 761 ~~U-240 — Np-240m~~
- 762 ~~Np-237 — Pa-233~~
- 763 ~~Am-242m — Am-242~~
- 764 ~~Am-243 — Np-239~~

- 765 c The quantity may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed
- 766 distance from the source.
- 767 d These values apply only to compounds of uranium that take the chemical form of UF₆, UO₂F₂ and UO₂(NO₃)₂ in both normal
- 768 and accident conditions of transport.
- 769 e These values apply only to compounds of uranium that take the chemical form of UO₃, UF₄, UCl₄, and hexavalent compounds in
- 770 both normal and accident conditions of transport.
- 771 f These values apply to all compounds of uranium other than those specified in d and e, above.
- 772 g These values apply to unirradiated uranium only.
- 773 h These values apply to domestic transport only. For international transport, use the values in the table below.

774 **TABLE 17A1 (SUPPLEMENT): A 1 AND A 2 VALUES FOR RADIONUCLIDES FOR**
 775 **INTERNATIONAL SHIPMENTS**

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Cf-252	Californium (98)	5.0x10 ⁻²	1.4	3.0x10 ⁻³	8.1x10 ⁻²	2.0x10 ¹	5.4x10 ²
Mo-99 ^c	Molybdenum (42)	1.0	2.7x10 ¹	6.0x10 ⁻¹	1.6x10 ¹	1.8x10 ⁴	4.8x10 ⁵

776

777 **TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT**
 778 **ACTIVITY LIMITS FOR RADIONUCLIDES Part 1 of 4**

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Ac-225 (a)	Actinium (89)	1.0 x 10 ¹	2.7 x 10 ⁻¹⁰	1.0 x 10 ⁴	2.7 x 10 ⁻⁷

		Document #10		RQ	
DRAFT 1 04/02/14					
Ac-227	.	1.0×10^{-1}	2.7×10^{-12}	1.0×10^3	2.7×10^{-8}
(a)					
Ac-228	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Ag-105	Silver	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
	(47)				
Ag-108m	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
(a)					
Ag-110m	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
(a)					
Ag-111	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Al-26	Aluminum	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
	(13)				
Am-241	Americium	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
	(95)				
Am-242m	.	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
(a)					
Am-243	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
(a)					
Ar-37	Argon	1.0×10^6	2.7×10^{-5}	1.0×10^8	2.7×10^{-3}
	(18)				
Ar-39	.	1.0×10^7	2.7×10^{-4}	1.0×10^4	2.7×10^{-7}
Ar-41	.	1.0×10^2	2.7×10^{-9}	1.0×10^9	2.7×10^{-2}
As-72	Arsenic	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
	(33)				
As-73	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
As-74	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
As-76	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
As-77	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
At-211 (a)	Astatine	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
	(85)				
Au-193	Gold	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
	(79)				
Au-194	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Au-195	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Au-198	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Au-199	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Ba-131	Barium	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
(a)	(56)				
Ba-133	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Ba-133m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Ba-140	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
(a)					
Be-7	Beryllium	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
	(4)				
Be-10	.	1.0×10^4	2.7×10^{-7}	1.0×10^6	2.7×10^{-5}
Bi-205	Bismuth	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}

		Document #10	RQ		
(83)					
Bi-206	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Bi-207	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Bi-210	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Bi-210m	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
(a)					
Bi-212 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Bk-247	Berkelium (97)	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Bk-249 ⁵	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Br-76	Bromine (35)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Br-77	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Br-82	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
C-11	Carbon (6)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
C-14	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Ca-41	Calcium (20)	1.0×10^5	2.7×10^{-6}	1.0×10^7	2.7×10^{-4}
Ca-45	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Ca-47 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Cd-109	Cadmium (48)	1.0×10^4	2.7×10^{-7}	1.0×10^6	2.7×10^{-5}
Cd-113m	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Cd-115	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
(a)					
Cd-115m	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Ce-139	Cerium (58)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Ce-141	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Ce-143	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Ce-144	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
(a)					
Cf-248	Californium (98)	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Cf-249	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Cf-250	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Cf-251	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Cf-252	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Cf-253 (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Cf-254	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Cl-36	Chlorine (17)	1.0×10^4	2.7×10^{-7}	1.0×10^6	2.7×10^{-5}
Cl-38	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Cm-240	Curium (96)	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}

		Document #10		RQ	
DRAFT 1 04/02/14					
Cm-241	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Cm-242	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Cm-243	.	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Cm-244	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Cm-245	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Cm-246	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Cm-247	.	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
(a)					
Cm-248	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Co-55	Cobalt (27)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Co-56	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Co-57	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Co-58	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Co-58m	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Co-60	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Cr-51	Chromium (24)	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Cs-129	Cesium (55)	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Cs-131	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Cs-132	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Cs-134	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Cs-134m	.	1.0×10^3	2.7×10^{-8}	1.0×10^5	2.7×10^{-6}
Cs-135	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Cs-136	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Cs-137 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Cu-64	Copper (29)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Cu-67	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Dy-159	Dysprosium (66)	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Dy-165	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Dy-166	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
(a)					
Er-169	Erbium (68)	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Er-171	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}

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780 **TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT**
 781 **ACTIVITY LIMITS FOR RADIONUCLIDES Part 2 of 4**

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material	Activity concentration for exempt material	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
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DRAFT 1 04/02/14		(Bq/g)	(Ci/g)		
Eu-147	Europium (63)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Eu-148	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Eu-149	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Eu-150	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
(short-lived)					
Eu-150	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
(long-lived)					
Eu-152	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Eu-152 m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Eu-154	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Eu-155	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Eu-156	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
F-18	Fluorine (9)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Fe-52 (a)	Iron (26)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Fe-55	.	1.0×10^4	2.7×10^{-7}	1.0×10^6	2.7×10^{-5}
Fe-59	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Fe-60 (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Ga-67	Gallium (31)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Ga-68	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Ga-72	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Gd-146	Gadolinium (64)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
(a)					
Gd-148	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Gd-153	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Gd-159	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Ge-68 (a)	Germanium (32)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Ge-71	.	1.0×10^4	2.7×10^{-7}	1.0×10^8	2.7×10^{-3}
Ge-77	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Hf-172	Hafnium (72)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
(a)					
Hf-175	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Hf-181	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Hf-182	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Hg-194	Mercury (80)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
(a)					
Hg-195m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
(a)					
Hg-197	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Hg-197m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Hg-203	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}

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Ho-166	Holmium (67)	1.0×10^3	2.7×10^{-8}	1.0×10^5	2.7×10^{-6}
Ho-166m	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
I-123	Iodine (53)	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
I-124	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
I-125	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
I-126	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
I-129	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
I-131	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
I-132	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
I-133	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
I-134	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
I-135 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
In-111	Indium (49)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
In-113m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
In-114m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
(a)					
In-115m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Ir-189 (a)	Iridium (77)	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Ir-190	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Ir-192	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Ir-194	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
K-40	Potassium (19)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
K-42	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
K-43	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Kr-81	Krypton (36)	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Kr-85	.	1.0×10^5	2.7×10^{-6}	1.0×10^4	2.7×10^{-7}
Kr-85m	.	1.0×10^3	2.7×10^{-8}	1.0×10^{10}	2.7×10^{-1}
Kr-87	.	1.0×10^2	2.7×10^{-9}	1.0×10^9	2.7×10^{-2}
La-137	Lanthanum (57)	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
La-140	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Lu-172	Lutetium (71)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Lu-173	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Lu-174	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Lu-174m	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Lu-177	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Mg-28 (a)	Magnesium (12)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Mn-52	Manganese	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}

		Document #10	RQ			
		DRAFT 1 04/02/14				
	(25)					
Mn-53	.	1.0×10^4	2.7×10^{-7}	1.0×10^9	2.7×10^{-2}	
Mn-54	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}	
Mn-56	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}	
Mo-93	Molybdenum (42)	1.0×10^3	2.7×10^{-8}	1.0×10^8	2.7×10^{-3}	
Mo-99 (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	
N-13	Nitrogen (7)	1.0×10^2	2.7×10^{-9}	1.0×10^9	2.7×10^{-2}	
Na-22	Sodium (11)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}	
Na-24	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}	
Nb-93m	Niobium (41)	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}	
Nb-94	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}	
Nb-95	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}	
Nb-97	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}	
Nd-147	Neodymium (60)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	
Nd-149	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	
Ni-59	Nickel (28)	1.0×10^4	2.7×10^{-7}	1.0×10^8	2.7×10^{-3}	
Ni-63	.	1.0×10^5	2.7×10^{-6}	1.0×10^8	2.7×10^{-3}	
Ni-65	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}	
Np-235	Neptunium (93)	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}	
Np-236 (short-lived)	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}	
Np-236 (long-lived)	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}	
Np-237	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}	
Np-239	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}	
Os-185	Osmium (76)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}	
Os-191	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}	
Os-191m	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}	
Os-193	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	

782

783 **TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT**
 784 **ACTIVITY LIMITS FOR RADIONUCLIDES Part 3 of 4**

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material	Activity concentration for exempt material	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
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		Document #10		RQ	
DRAFT 1 04/02/14		(Bq/g)	(Ci/g)		
Os-194 (a)	Osmium (76)	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
P-32	Phosphorus (15)	1.0×10^3	2.7×10^{-8}	1.0×10^5	2.7×10^{-6}
P-33	.	1.0×10^5	2.7×10^{-6}	1.0×10^8	2.7×10^{-3}
Pa-230(a)	Protactinium (91)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Pa-231	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Pa-233	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Pb-201	Lead (82)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Pb-202	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Pb-203	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Pb-205	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Pb-210 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Pb-212 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Pd-103 (a)	Palladium (46)	1.0×10^3	2.7×10^{-8}	1.0×10^8	2.7×10^{-3}
Pd-107	.	1.0×10^5	2.7×10^{-6}	1.0×10^8	2.7×10^{-3}
Pd-109	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Pm-143	Promethium (61)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Pm-144	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Pm-145	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Pm-147	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Pm-148m (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Pm-149	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Pm-151	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Po-210	Polonium (84)	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Pr-142	Praseodymium (59)	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Pr-143	.	1.0×10^4	2.7×10^{-7}	1.0×10^6	2.7×10^{-5}
Pt-188 (a)	Platinum (78)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Pt-191	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Pt-193	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Pt-193m	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Pt-195m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Pt-197	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Pt-197m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Pu-236	Plutonium (94)	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}

		Document #10	RQ		
DRAFT 1 04/02/14					
Pu-237	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Pu-238	.	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Pu-239	.	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Pu-240	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Pu-241	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
(a)					
Pu-242	.	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Pu-244	.	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
(a)					
Ra-223	Radium	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
(a)	(88)				
Ra-224	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
(a)					
Ra-225	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
(a)					
Ra-226	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
(a)					
Ra-228	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
(a)					
Rb-81	Rubidium	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
	(37)				
Rb-83 (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Rb-84	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Rb-86	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Rb-87	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Rb	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
(natural)					
Re-184	Rhenium	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
	(75)				
Re-184m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Re-186	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Re-187	.	1.0×10^6	2.7×10^{-5}	1.0×10^9	2.7×10^{-2}
Re-188	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Re-189	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
(a)					
Re	.	1.0×10^6	2.7×10^{-5}	1.0×10^9	2.7×10^{-2}
(natural)					
Rh-99	Rhodium	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
	(45)				
Rh-101	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Rh-102	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Rh-102m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Rh-103m	.	1.0×10^4	2.7×10^{-7}	1.0×10^8	2.7×10^{-3}
Rh-105	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Rn-222	Radon (86)	1.0×10^1	2.7×10^{-10}	1.0×10^8	2.7×10^{-3}
(a)					

		Document #10	RQ			
DRAFT 1 04/02/14						
Ru-97	Ruthenium (44)	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}	
Ru-103 (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	
Ru-105	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}	
Ru-106 (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}	
S-35	Sulphur (16)	1.0×10^5	2.7×10^{-6}	1.0×10^8	2.7×10^{-3}	
Sb-122	Antimony (51)	1.0×10^2	2.7×10^{-9}	1.0×10^4	2.7×10^{-7}	
Sb-124	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}	
Sb-125	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	
Sb-126	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}	
Sc-44	Scandium (21)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}	
Sc-46	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}	
Sc-47	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	
Sc-48	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}	
Se-75	Selenium (34)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	
Se-79	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}	
Si-31	Silicon (14)	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}	
Si-32	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}	
Sm-145	Samarium (62)	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}	
Sm-147	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}	
Sm-151	.	1.0×10^4	2.7×10^{-7}	1.0×10^8	2.7×10^{-3}	
Sm-153	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	
Sn-113 (a)	Tin (50)	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}	
Sn-117m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	
Sn-119m	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}	
Sn-121m (a)	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}	
Sn-123	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}	
Sn-125	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}	
Sn-126 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}	
Sr-82 (a)	Strontium (38)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}	
Sr-85	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}	
Sr-85m	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}	

Document #10

RQ

DRAFT 1 04/02/14

786
787

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES Part 4 of 4

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Sr-87m	Strontium (38)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Sr-89	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Sr-90 (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^4	2.7×10^{-7}
Sr-91 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Sr-92 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
T(H-3)	Tritium (1)	1.0×10^6	2.7×10^{-5}	1.0×10^9	2.7×10^{-2}
Ta-178 (long-lived)	Tantalum (73)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Ta-179	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Ta-182	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Tb-157	Terbium (65)	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Tb-158	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Tb-160	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Tc-95m (a)	Technetium (43)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Tc-96	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Tc-96m (a)	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Tc-97	.	1.0×10^3	2.7×10^{-8}	1.0×10^8	2.7×10^{-3}
Tc-97m	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Tc-98	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Tc-99	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Tc-99m	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Te-121	Tellurium (52)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Te-121m	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Te-123m	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Te-125m	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Te-127	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Te-127m (a)	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Te-129	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Te-129m (a)	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Te-131m (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Te-132 (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Th-227	Thorium (90)	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Th-228 (a)	.	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}

DRAFT 1 04/02/14		Document #10	RQ		
Th-229	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Th-230	.	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Th-231	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Th-232	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Th-234 (a)	.	1.0×10^3	2.7×10^{-8}	1.0×10^5	2.7×10^{-6}
Th (natural)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Ti-44 (a)	Titanium (22)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Tl-200	Thallium (81)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Tl-201	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Tl-202	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Tl-204	.	1.0×10^4	2.7×10^{-7}	1.0×10^4	2.7×10^{-7}
Tm-167	Thulium (69)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Tm-170	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Tm-171	.	1.0×10^4	2.7×10^{-7}	1.0×10^8	2.7×10^{-3}
U-230 (fast lung absorption) (a),(bd)	Uranium (92)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
U-230 (medium lung absorption) (a),(ec)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
U-230 (slow lung absorption) (a),(fd)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
U-232 (fast lung absorption) (bd)	Uranium (92)	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U-232 (medium lung absorption) (ec)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U-232 (slow lung absorption) (fd)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U-233 (fast lung absorption)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}

Comment [JJ27]: The footnote lettering of this series of tables is updated to correspond to the relocated footnotes following the table.

DRAFT 1 04/02/14		Document #10	RQ		
(db)					
U-233	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
(medium lung absorption)					
(ec)					
U-233 (slow lung absorption)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
(fd)					
U-234 (fast lung absorption)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
(db)					
U-234 (medium lung absorption)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
(ec)					
U-234 (slow lung absorption)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
(fd)					
U-235 (all lung absorption types)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
(a),(db),(ec),(fd)					
U-236 (fast lung absorption)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
(db)					
U-236 (medium lung absorption)	Uranium (92)	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
(ec)					
U-236 (slow lung absorption)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
(fd)					
U-238 (all lung absorption types)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}

DRAFT 1 04/02/14		Document #10	RQ		
(db),(ce),(fd)					
U (natural)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U (enriched to 20% or less) (ge)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U (depleted)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
V-48	Vanadium (23)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
V-49	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
W-178 (a)	Tungsten (74)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
W-181	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
W-185	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
W-187	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
W-188 (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Xe-122 (a)	Xenon (54)	1.0×10^2	2.7×10^{-9}	1.0×10^9	2.7×10^{-2}
Xe-123	.	1.0×10^2	2.7×10^{-9}	1.0×10^9	2.7×10^{-2}
Xe-127	.	1.0×10^3	2.7×10^{-8}	1.0×10^5	2.7×10^{-6}
Xe-131m	.	1.0×10^4	2.7×10^{-7}	1.0×10^4	2.7×10^{-7}
Xe-133	.	1.0×10^3	2.7×10^{-8}	1.0×10^4	2.7×10^{-7}
Xe-135	.	1.0×10^3	2.7×10^{-8}	1.0×10^{10}	2.7×10^{-1}
Y-87 (a)	Yttrium (39)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Y-88	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Y-90	.	1.0×10^3	2.7×10^{-8}	1.0×10^5	2.7×10^{-6}
Y-91	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Y-91m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Y-92	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Y-93	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Yb-169	Ytterbium (79)	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Yb-175	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Zn-65	Zinc (30)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Zn-69	.	1.0×10^4	2.7×10^{-7}	1.0×10^6	2.7×10^{-5}
Zn-69m (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Zr-88	Zirconium (40)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Zr-93	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Zr-95 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Zr-97 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}

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a [Parent nuclides and their progeny included in secular equilibrium are listed in the following:](#)

[Sr-90 Y-90](#)

[Zr-93 Nb-93m](#)

Comment [JJ28]: The footnotes here are relocated from the prior table (Table 17A1) as they pertain to Table 17A2.

Document #10

RQ

DRAFT 1 04/02/14

- 792 Zr-97 Nb-97
- 793 Ru-106 Rh-106
- 794 Cs-137 Ba-137m
- 795 Ce-134 La-134
- 796 Ce-144 Pr-144
- 797 Ba-140 La-140
- 798 Bi-212 Tl-208 0.36 . Po-212 0.64
- 799 Pb-210 Bi-210, Po-210
- 800 Pb-212 Bi-212, Tl-208 0.36 . Po-212 0.64
- 801 Rn-220 Po-216
- 802 Rn-222 Po-218, Pb-214, Bi-214, Po-214
- 803 Ra-223 Rn-219, Po-215, Pb-211, Bi-211, Tl-207
- 804 Ra-224 Rn-220, Po-216, Pb-212, Bi-212, Tl-208 0.36 . Po-212 0.64
- 805 Ra-226 Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
- 806 Ra-228 Ac-228
- 807 Th-226 Ra-222, Rn-218, Po-214
- 808 Th-228 Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 0.36 . Po-212 0.64
- 809 Th-229 Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
- 810 Th-nat Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 0.36 . Po-12 0.64
- 811 Th-234 Pa-234m
- 812 U-230 Th-226, Ra-222, Rn-218, Po-214
- 813 U-232 Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 0.36 . Po-212 0.64
- 814 U-235 Th-231
- 815 U-238 Th-234, Pa-234m
- 816 U-nat Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214,
- 817 U-240 Np-240m
- 818 Np-237 Pa-233
- 819 Am-242m Am-242
- 820 Am-243 Np-239
- 821
- 822 **b** These values apply only to compounds of uranium that take the chemical form of UF₆, UO₂F₂ and UO₂(NO₃)₂ in both
- 823 normal and accident conditions of transport.
- 824 **c** These values apply only to compounds of uranium that take the chemical form of UO₃, UF₄, UCl₄, and hexavalent
- 825 compounds in both normal and accident conditions of transport.
- 826 **d** These values apply to all compounds of uranium other than those specified in d and e, above.
- 827 **e** These values apply to unirradiated uranium only.
- 828

Comment [JJ29]: Footnotes c through e are added for consistency with equivalent tables of Appendix A of 10 CFR 71.

829 **TABLE 17A3: GENERAL VALUES FOR A 1 AND A 2**

Contents	A ₁ (TB q)	A ₁ (C i)	A ₂ (TB q)	A ₂ (C i)	Activity concentration for exempt material(B q/g)	Activity concentration for exempt material(C i/g)	Activity limits for exempt material consig	Activity limits for exempt material consig
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Document #10

RQ

DRAFT 1 04/02/14

							n-ments (Bq)	n-ments (Ci)
Only beta or gamma emitting radionuclides are known to be present	1×10^{-1}	2.7×10^0	2×10^{-2}	5.4×10^{-1}	1×10^{-1}	2.7×10^{-10}	1×10^4	2.7×10^{-7}
Only alpha emitting radionuclides are known to be present	2×10^{-1}	5.4×10^0	9×10^{-5}	2.4×10^{-3}	1×10^{-1}	2.7×10^{-12}	1×10^3	2.7×10^{-8}
No relevant data are available	1×10^{-3}	2.7×10^{-2}	9×10^{-5}	2.4×10^{-3}	1×10^{-1}	2.7×10^{-12}	1×10^3	2.7×10^{-8}

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831 TABLE 17A4: ACTIVITY-MASS RELATIONSHIPS FOR URANIUM

Uranium Enrichment (i) weight % U-235 present	Specific Activity	
	TBq/g	Ci/g
.	1.8×10^{-8}	5.0×10^{-7}
0.45	2.6×10^{-8}	7.1×10^{-7}
0.72	2.8×10^{-8}	7.6×10^{-7}
1.0	3.7×10^{-8}	1.0×10^{-6}
1.5	1.0×10^{-7}	2.7×10^{-6}
5.0	1.8×10^{-7}	4.8×10^{-6}
10.0	3.7×10^{-7}	1.0×10^{-5}
20.0	7.4×10^{-7}	2.0×10^{-5}
35.0	9.3×10^{-7}	2.5×10^{-5}
50.0	2.2×10^{-6}	5.8×10^{-5}
90.0	2.6×10^{-6}	7.0×10^{-5}
93.0	3.4×10^{-6}	9.1×10^{-5}
95.0		

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833 1 The figures for uranium include representative values for the activity of the uranium-235 that is concentrated during the enrichment process.

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Document #10**RQ****DRAFT 1 04/02/14**836 **EDITOR'S NOTES**

837 6 CCR 1007-1 has been divided into smaller sections for ease of use. Versions prior to 4/1/07 and rule
838 history are located in the first section, 6 CCR 1007-1. Prior versions can be accessed from the History link
839 that appears above the text in 6 CCR 1007-1. To view versions effective on or after 4/1/07, Select the
840 desired part of the rule, for example 6 CCR 1007-1 Part 1 or 6 CCR 1007-1 Parts 8 - 10.

841 **History**

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