

DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Hazardous Materials and Waste Management Division

RADIATION CONTROL - TRANSPORTATION OF RADIOACTIVE MATERIALS

6 CCR 1007-1 Part 17

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

Adopted by the Board of Health October 19, 2022, effective date December 15, 2022.

PART 17: TRANSPORTATION OF RADIOACTIVE MATERIALS

GENERAL PROVISIONS

17.1 Purpose and Scope.

17.1.1 Authority.

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

17.1.2 Basis and Purpose.

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

17.1.3 Scope.

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

17.1.4 Applicability.

17.1.4.1 This part applies to any person who transports radioactive material or delivers radioactive material to a carrier for transport.

- (1) This part applies in particular to any licensee authorized by specific or general license to receive, possess, use, or transfer licensed material, if the licensee delivers that material to a carrier for transport, transports the material outside the site of usage as specified in the license, or transports that material on a public highway.
- (2) The transport of licensed material or delivery of licensed material to a carrier for transport is subject to the:
 - (a) General provisions of 17.1 through 17.5, including referenced DOT regulations;
 - (b) Quality assurance requirements of 10 CFR Part 71; and
 - (c) Operating controls and procedures requirements of 17.11 through 17.17.

- (3) No provision of this part authorizes possession of licensed material.
- (4) Exemptions from the requirement in 17.3 for a license are specified in 17.4.
- (5) The general license under 17.7 requires that a NRC Certificate of Compliance or other package approval be issued for the package to be used under the general license.
- (6) General licenses for which no package approval is required are issued in 17.8 and 17.9.
- (7) These rules apply to any person required to obtain a Certificate of Compliance or an approved compliance plan from the NRC pursuant to 10 CFR Part 71 if the person delivers radioactive material to a common or contract carrier for transport or transports the material outside the confines of the person's plant or other authorized place of use.

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

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

17.1.5 Published Material Incorporated by Reference.

17.1.5.1 Throughout this Part 17, federal regulations, state regulations, and standards or guidelines of outside organizations have been adopted and incorporated by reference. Unless a prior version of the incorporated material is otherwise specifically indicated, the materials incorporated by reference cited herein include only those versions that were in effect as of the most recent effective date of this Part 17 (December 2022), and not later amendments or editions of the incorporated material.

17.1.5.2 Materials incorporated by reference are available for public inspection, and copies (including certified copies) can be obtained at reasonable cost, during normal business hours from the Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division, 4300 Cherry Creek Drive South, Denver, Colorado 80246. Additionally, <https://www.colorado.gov/cdphe/radregs> identifies where the incorporated material is available to the public on the internet at no cost. Due to copyright restrictions, certain materials incorporated in this Part are available for public inspection at the state publications depository and distribution center.

17.1.5.3 Availability from Source Agencies or Organizations.

- (1) All federal agency regulations incorporated by reference herein are available at no cost in the online edition of the Code of Federal Regulations (CFR) hosted by the U.S. Government Printing Office, online at www.govinfo.gov.
- (2) All state regulations incorporated by reference herein are available at no cost in the online edition of the Code of Colorado Regulations (CCR) hosted by the Colorado Secretary of State's Office, online at <https://www.sos.state.co.us/CCR/RegisterHome.do>.

17.2 Definitions.

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

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

"Certificate holder" means a person who has been issued a Certificate of Compliance or other package approval by the NRC.

"Certificate of Compliance" (COC) means the certificate issued by the NRC under subpart D of 10 CFR Part 71 which approves the design of a package for the transportation of radioactive material.

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

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

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

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

- (1) *Fixed contamination* means contamination that cannot be removed from a surface during normal conditions of transport.
- (2) *Non-fixed contamination* means contamination that can be removed from a surface during normal conditions of transport.

"Conveyance" means:

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

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

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

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

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

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

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

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

- (1) LSA-I.
 - (a) Uranium and thorium ores, concentrates of uranium and thorium ores, and other ores containing naturally occurring radionuclides that are intended to be processed for the use of these radionuclides;
 - (b) Natural uranium, depleted uranium, natural thorium or their compounds or mixtures, provided they are unirradiated and in solid or liquid form;
 - (c) Radioactive material, other than fissile material, for which the A_2 value in Appendix 17A is unlimited; or
 - (d) Other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the value for exempt material activity concentration determined in accordance with Appendix 17A.
- (2) LSA-II.
 - (a) Water with tritium concentration up to 0.8 TBq/liter (20.0 Ci/liter); or
 - (b) Other radioactive material in which the activity is distributed throughout, and the estimated average specific activity does not exceed $10^{-4} \times A_2/g$ for solids and gases, and $10^{-5} \times A_2/g$ for liquids.
- (3) LSA-III. Solids (e.g., consolidated wastes, activated materials), excluding powders, that satisfy the requirements of 10 CFR Part 71.77, in which:

- (a) The radioactive material is distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.);
- (b) The radioactive material is relatively insoluble, or it is intrinsically contained in a relatively insoluble material, so that, even under loss of packaging, the loss of radioactive material per package by leaching, when placed in water for 7 days, will not exceed $0.1 \times A_2$; and
- (c) The estimated average specific activity of the solid, excluding any shielding material, does not exceed $2 \times 10^{-3} A_2/g$; and

“Low toxicity alpha emitters” means natural uranium, depleted uranium, natural thorium; uranium-235, uranium-238, thorium-232, thorium-228 or thorium-230 when contained in ores or physical or chemical concentrates or tailings; or alpha emitters with a half-life of less than 10 days.

“Nuclear waste” means, for the purposes of Part 17, a quantity of source, byproduct or special nuclear material required to be in NRC-approved specification packaging while transported to, through or across a state boundary to a disposal site, or to a collection point for transport to a disposal site.

“Packaging” means the assembly of components necessary to ensure compliance with the packaging requirements of 10 CFR Part 71. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle, tie-down system, and auxiliary equipment may be designated as part of the packaging.

“Quality assurance”, for the purposes of Part 17, comprises all those planned and systematic actions necessary to provide adequate confidence that a system or component will perform satisfactorily in service.

“Quality control”, for the purposes of Part 17, comprises those quality assurance actions that relate to control of the physical characteristics and quality of the material or component to predetermined requirements.

“Regulations of the DOT” means the regulations in 49 CFR Parts 100-189 and Parts 390-397.

“Regulations of the NRC” means the regulations in 10 CFR Part 71 for purposes of Part 17.

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

- (1) SCO-I: a solid object on which:
 - (a) The non-fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 4 Bq/cm^2 (10^{-4} microcurie/ cm^2) for beta, gamma and low toxicity alpha emitters, or 0.4 Bq/cm^2 (10^{-5} microcurie/ cm^2) for all other alpha emitters;
 - (b) The fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $4 \times 10^4 \text{ Bq/cm}^2$ (1.0 microcurie/ cm^2) for beta, gamma and low toxicity alpha emitters, or $4 \times 10^3 \text{ Bq/cm}^2$ (0.1 microcurie/ cm^2) for all other alpha emitters; and

- (c) The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 4 x 10⁴ Bq/cm² (1 microcurie/cm²) for beta, gamma and low toxicity alpha emitters, or 4 x 10³ Bq/cm² (0.1 microcurie/cm²) for all other alpha emitters.
- (2) SCO-II: a solid object on which the limits for SCO-I are exceeded and on which:
- (a) The non-fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 400 Bq/cm² (10⁻² microcurie/cm²) for beta, gamma and low toxicity alpha emitters or 40 Bq/cm² (10⁻³ microcurie/cm²) for all other alpha emitters;
 - (b) The fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 8 x 10⁵ Bq/cm² (20 microcuries/cm²) for beta, gamma and low toxicity alpha emitters, or 8 x 10⁴ Bq/cm² (2 microcuries/cm²) for all other alpha emitters; and
 - (c) The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 8 x 10⁵ Bq/cm² (20 microcuries/cm²) for beta, gamma and low toxicity alpha emitters, or 8 x 10⁴ Bq/cm² (2 microcuries/cm²) for all other alpha emitters.

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

“Tribal official” means the highest ranking individual that represents Tribal leadership, such as the Chief, President, or Tribal Council leadership.

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

“Type A packaging” means a packaging designed for a Type A package.

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

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

“Type B package” means a Type B packaging together with its radioactive contents.¹

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

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

“Type B quantity” means a quantity of radioactive material greater than a Type A quantity.

“Uranium – natural, depleted, enriched”.

- (1) “Natural uranium” means, for the purposes of Part 17, uranium (which may be chemically separated) with the naturally occurring distribution of uranium isotopes (approximately 0.711 weight percent uranium-235 and the remainder by weight essentially uranium-238).
- (2) “Depleted uranium” means, for the purposes of Part 17, uranium containing less uranium-235 than the naturally occurring distribution of uranium isotopes.
- (3) “Enriched uranium” means, for the purposes of Part 17, uranium containing more uranium 235 than the naturally occurring distribution of uranium isotopes.

LICENSE-RELATED REGULATORY REQUIREMENTS

17.3 Requirement for License.

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

17.4 Exemptions.

17.4.1 Common and contract carriers, freight forwarders, and warehouse workers which are subject to the requirements of the DOT in 49 CFR Part 170 through 189, or the U.S. Postal Service in the Postal Service Manual (Domestic Mail Manual), are exempt from the requirements of Part 17 to the extent that they transport or store radioactive material in the regular course of their carriage for others or storage incident thereto. Common and contract carriers who are not subject to the requirements of the DOT or U.S. Postal Service are subject to 17.3 and other applicable requirements of these regulations.

17.4.2 A licensee is exempt from the requirements of Part 17 with respect to shipment or carriage of the following low-level materials:

17.4.2.1 Natural material and ores containing naturally occurring radionuclides that are either in their natural state, or have only been processed for purposes other than for the extraction of the radionuclides, and which are not intended to be processed for the use of these radionuclides, provided the activity concentration of the material does not exceed 10 times the applicable radionuclide activity concentration values specified in Appendix 17A, Table 17A2, or Table 17A3 of this part.

- 17.4.2.2 Materials for which the activity concentration is not greater than the activity concentration values specified in Appendix 17A, Table 17A2, or Table 17A3 of this part, or for which the consignment activity is not greater than the limit for an exempt consignment found in Appendix 17A, Table 17A2 or Table 17A3 of this part.
- 17.4.2.3 Non-radioactive solid objects with radioactive substances present on any surfaces in quantities not in excess of the levels cited in the definition of contamination in 17.2.
- 17.4.3 Fissile materials meeting the requirements of one of the paragraphs (a) through (f) in 10 CFR Part 71.15 are exempt from classification as fissile material, and from the fissile material package standards of 10 CFR Part 71.55 and 10 CFR Part 71.59, but are subject to all other requirements of 10 CFR Part 71, except as noted in paragraphs (a) through (f) in 10 CFR Part 71.15.
- 17.4.4 Any physician licensed by a state to dispense drugs in the practice of medicine is exempt from 17.5 with respect to transport by the physician of licensed material for use in the practice of medicine. However, any physician operating under this exemption must be licensed under Part 7 or equivalent requirements of another Agreement State or NRC.

17.5 Transportation of Licensed Material.

- 17.5.1 Each licensee who transports licensed material outside the site of usage, as specified in the Department license, or where transport is on public highways, or who delivers licensed material to a carrier for transport, shall:
- 17.5.1.1 Comply with the applicable requirements, appropriate to the mode of transport, of the regulations of the DOT, particularly the regulations of the DOT in the following areas:
- (1) Packaging - 49 CFR Part 173: Subparts A and B and I.
 - (2) Marking and labeling - 49 CFR Part 172: Subpart D, § § 172.400 through 172.407, § § 172.436 through 172.441, and Subpart E.
 - (3) Placarding - 49 CFR Part 172: Subpart F, especially § § 172.500 through 172.519, 172.556, and Appendices B and C.
 - (4) Accident reporting - 49 CFR Part 171: § § 171.15 and 171.16.
 - (5) Shipping papers and emergency information - 49 CFR Part 172: Subparts C and G.
 - (6) Hazardous material employee training - 49 CFR Part 172: Subpart H.
 - (7) Security plans - 49 CFR Part 172: Subpart I.
 - (8) Hazardous material shipper/carrier registration - 49 CFR Part 107: Subpart G.
- 17.5.1.2 The licensee shall also comply with applicable regulations of the DOT pertaining to the following modes of transportation:
- (1) Rail - 49 CFR Part 174: Subparts A through D, and K.
 - (2) Air - 49 CFR Part 175.
 - (3) Vessel - 49 CFR Part 176: Subparts A through F, and M.

(4) Public highway - 49 CFR Part 177 and Parts 390 through 397.

17.5.1.3 Assure that any special instructions needed to safely open the package are sent to or have been made available to the consignee in accordance with 4.32.5.2.

17.5.2 If, for any reason, the regulations of the DOT are not applicable to a shipment of licensed material, the licensee shall conform to the standards and requirements of 49 CFR Parts 170 through 189 appropriate to the mode of transport to the same extent as if the shipment was subject to these regulations.

GENERAL LICENSES

17.6 General Licenses for Carriers.

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

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 the notification made to the DOT or other agencies.

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

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

17.7 General License: NRC-Approved Packages.

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

17.7.2 This general license applies only to a licensee who has a quality assurance program approved by the Department as satisfying the provisions of Subpart H (excluding 71.101(c)(2), (d), and (e) and 71.107 through 71.125) of 10 CFR Part 71.

17.7.3 Each licensee issued a general license under Section 17.7.1 shall:

17.7.3.1 Maintain a copy of the Certificate of Compliance, or other approval of the package, and the drawings and other documents referenced in the approval relating to the use and maintenance of the packaging and to the actions to be taken before shipment;

17.7.3.2 Comply with the terms and conditions of the license, Certificate of Compliance, or other approval issued by the NRC, as applicable, and the applicable requirements of Subparts A (excluding 71.11), G (excluding 71.85(a)-(c), and 71.91(b)), and H (excluding 71.101(c)(2), (d), and (e) and 71.107 through 71.125) of 10 CFR Part 71; and

17.7.3.3 Submit in writing before the first use of the package to: ATTN: Document Control Desk, Director, Division of Fuel Management, Office of Nuclear Material Safety and Safeguards, using an appropriate method listed in 10 CFR Part 71.1(a), the licensee's name and license number and the package identification number specified in the package approval.

17.7.4 The general license in 17.7.1 applies only when the package approval authorizes use of the package under this general license.

17.7.5 For a Type B or fissile material package, the design of which was approved by NRC before April 1, 1996, the general license in 17.7.1 is subject to additional restrictions of 10 CFR Part 71.19.

17.8 General Licenses: Use of Foreign-Approved and Other Approved Packages

17.8.1 A general license is issued to any licensee of the Department to transport, or to deliver to a carrier for transport, licensed material in a package, the design of which has been approved in a foreign national competent authority certificate, that has been revalidated by the DOT as meeting the applicable requirements of 49 CFR Part 171.23.

17.8.2 Except as otherwise provided in this section, the general license applies only to a licensee who has a quality assurance program approved by the Department as satisfying the applicable provisions of 10 CFR Part 71.101 through 71.137, excluding 71.101(c)(2), (d), and (e) and 71.107 through 71.125.

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

17.8.4 Each licensee issued a general license under Section 17.8.1 shall:

- (1) Maintain a copy of the applicable certificate, the revalidation, and the drawings and other documents referenced in the certificate, relating to the use and maintenance of the packaging and to the actions to be taken before shipment; and
- (2) Comply with the terms and conditions of the certificate and revalidation, and with the applicable requirements of Part 17, sections 17.1 through 17.5, 17.10 through 17.17, and Subparts A (excluding 71.11), G (excluding 71.85(a)-(c), and 71.91(b)), and H (excluding 71.101(c)(2), (d), and (e) and 71.107 through 71.125) of 10 CFR Part 71.

17.9 General Licenses: Fissile Material Transport

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

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

QUALITY ASSURANCE

17.10 Quality Assurance Requirements.

17.10.1 Subpart H of 10 CFR Part 71 describes quality assurance requirements applying to design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, and modification of components of packaging that are important to safety. As used in Subpart H of 10 CFR Part 71, "quality assurance" comprises all those planned and systematic actions necessary to provide adequate confidence that a system or component will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality assurance actions related to control of the physical characteristics and quality of the material or component to predetermined requirements.

17.10.2 Each licensee is responsible for satisfying the applicable quality assurance requirements that apply to its use of a packaging for the shipment of licensed material subject to the applicable requirements set forth in Subpart H of 10 CFR Part 71 (excluding 10 CFR Part 71.101(c)(2), (d), and (e) and 10 CFR Part 71.107 through 71.125).

17.10.3 Before the use of any package for the shipment of licensed material subject to Subpart H of 10 CFR Part 71, each licensee shall obtain Department approval of its quality assurance program. Each licensee shall file with the Department, a description of its quality assurance program, including a discussion of which requirements of Subpart H of 10 CFR Part 71 are applicable and how they will be satisfied.

17.10.4 Radiography containers.

A program for transport container inspection and maintenance limited to radiographic exposure devices, source changers, or packages transporting these devices and meeting the requirements of Part 5, sections 5.12.4 through 5.12.6 or equivalent Agreement State or NRC requirement, is deemed to satisfy the requirements of 17.7.2 and 10 CFR Part 71.101(b).

17.11 Advance Notification of Shipment of Nuclear Waste.

17.11.1 As specified in 17.11.3, 17.11.4, and 17.11.5, each licensee shall provide advance notification to the governor of a state, or the governor's designee, of the shipment of licensed material (nuclear waste), within or across the boundary of the state, before the transport, or delivery to a carrier, for transport, of licensed material outside the confines of the licensee's plant or other place of use or storage.

17.11.2 As specified in 17.11.3, 17.11.4, and 17.11.5 of this section, after June 11, 2013, each licensee shall provide advance notification to the Tribal official of participating Tribes referenced in 17.11.4.3(3), or the official's designee, of the shipment of licensed material, within or across the boundary of the Tribe's reservation, before the transport, or delivery to a carrier, for transport, of licensed material outside the confines of the licensee's plant or other place of use or storage.

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

17.11.3.1 The licensed material is required by this part to be in Type B packaging for transportation;

17.11.3.2 The licensed material is being transported to or across a state boundary en route to a disposal facility or to a collection point for transport to a disposal facility; and

17.11.3.3 The quantity of licensed material in a single package exceeds the least of the following:

- (1) 3000 times the A1 value of the radionuclides as specified in Appendix 17A, Table A1 for special form radioactive material; or
- (2) 3000 times the A2 value of the radionuclides as specified in Appendix 17A, Table A1 for normal form radioactive material; or
- (3) 1000 TBq (27,000 Ci).

17.11.4 Procedures for submitting advance notification

17.11.4.1 The notification must be made in writing to:

- (1) The office of each appropriate governor or governor's designee;
- (2) The office of each appropriate Tribal official or Tribal official's designee;
- (3) The Department; and
- (4) The NRC's Director, Office of Nuclear Security and Incident Response.

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

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

- (1) RESERVED.
- (2) Contact information for each State, including telephone and mailing addresses of governors and governors' designees, and participating Tribes, including telephone and mailing addresses of Tribal officials and Tribal official's designees, is available on the NRC Web site at: <https://scp.nrc.gov/special/designee.pdf>.
- (3) A list of the names and mailing addresses of the governor's designees and Tribal official's designees of participating Tribes is available on request from the Director, Division of Materials Safety, Security, State, and Tribal Programs, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

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

17.11.5 Information to be furnished in advance notification of shipment.

17.11.5.1 Each advance notification of nuclear waste shall contain the following information:

- (1) The name, address, and telephone number of the shipper, carrier, and receiver of the nuclear waste shipment;

- (2) A description of the nuclear waste contained in the shipment, as required by 49 CFR Part 172.202 and 172.203(d);
- (3) The point of origin of the shipment and the 7-day period during which departure of the shipment is estimated to occur;
- (4) The 7-day period during which arrival of the shipment at state boundaries or Tribal reservation boundaries is estimated to occur;
- (5) The destination of the shipment, and the 7-day period during which arrival of the shipment is estimated to occur; and
- (6) A point of contact with a telephone number for current shipment information.

17.11.6 Revision notice

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

- (1) Telephone a responsible individual in the office of the governor of the state or of the governor's designee or the Tribal official or Tribal official's designee an inform that individual of the extent of the delay beyond the schedule originally reported; and
- (2) Maintain a record of the name of the individual contacted for 3 years.

17.11.7 Cancellation notice

17.11.7.1 Each licensee who cancels a nuclear waste shipment, for which advance notification has been sent, shall:

- (1) Send a cancellation notice to the governor of each state, or governor's designee previously notified, each Tribal official or Tribal official's designee previously notified, the NRC's Director, Office of Nuclear Security and Incident Response, and to the Department;
- (2) State in the notice that it is a cancellation and identify the advance notification that is being cancelled; and
- (3) Retain a copy of the notice for 3 years.

17.12 Air Transport of Plutonium.

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

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

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

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

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

OPERATING CONTROLS AND PROCEDURES

17.13 Fissile Material: Assumptions as to Unknown Properties of Fissile Material.

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

17.14 Preliminary Determinations.

Before the first use of any packaging for the shipment of radioactive material the licensee shall ascertain that the determinations in paragraphs (a) through (c) of 10 CFR Part 71.85 have been made by the certificate holder.

17.15 Routine Determinations.

Prior to each shipment of licensed material, the licensee shall determine that:

17.15.1 The package is proper for the contents to be shipped;

17.15.2 The package is in unimpaired physical condition except for superficial defects such as marks or dents;

17.15.3 Each closure device of the packaging, including any required gasket, is properly installed and secured and free of defects;

17.15.4 Any system for containing liquid is adequately sealed and has adequate space or other specified provision for expansion of the liquid;

17.15.5 Any pressure relief device is operable and set in accordance with written procedures;

17.15.6 The package has been loaded and closed in accordance with written procedures;

17.15.7 Any structural part of the package which could be used to lift or tie down the package during transport is rendered inoperable for the purpose unless it satisfies design requirements specified in 10 CFR Part 71.45;

17.15.8 The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment is as low as reasonably achievable and within the limits specified in 49 CFR Part 173.443.

17.15.8.1 Determination of the level of non-fixed (removable) contamination shall be based upon wiping an area of 300 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material.

- (1) The number and location of measurements shall be sufficient to yield a representative assessment of the removable contamination levels.
- (2) Other methods of assessment of equal or greater detection efficiency may be used.

17.15.8.2 In the case of packages transported as exclusive use shipments by rail or highway only, the non-fixed (removable) radioactive contamination:

- (1) At the beginning of transport shall not exceed the levels specified in 49 CFR Part 173.443; and
- (2) At any time during transport shall not exceed 10 times the levels specified in 49 CFR Part 173.443.

17.15.9 External radiation levels around the package and around the vehicle, if applicable, shall not exceed:

17.15.9.1 2 mSv/h (200 millirem per hour) at any point on the external surface of the package at any time during transportation;

17.15.9.2 A transport index of 10.0.

17.15.10 For a package transported in exclusive use by rail, highway or water, radiation levels external to the package may exceed the limits specified in 17.15.9 but shall not exceed any of the following:

17.15.10.1 2 mSv/h (200 millirem per hour) on the accessible external surface of the package unless the following conditions are met, in which case the limit is 10 mSv/h (1000 millirem per hour);

- (1) The shipment is made in a closed transport vehicle,
- (2) Provisions are made to secure the package so that its position within the vehicle remains fixed during transportation, and
- (3) No loading or unloading operation occurs between the beginning and end of the transportation.

17.15.10.2 2 mSv/h (200 millirem per hour) at any point on the outer surface of the vehicle, including the upper and lower surfaces, or, in the case of a flat-bed style vehicle, with a personnel barrier, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load (or enclosure, if used), and on the lower external surface of the vehicle;

- (1) A flat bed style vehicle with a personnel barrier shall have radiation levels determined at vertical planes.
- (2) If no personnel barrier is in place, the package cannot exceed 2 mSv/h (200 millirem per hour) at any accessible surface.

17.15.10.3 0.1 mSv/h (10 millirem per hour) at any point 2 meters from the vertical planes represented by the outer lateral surfaces of the vehicle, or, in the case of a flat-bed style vehicle, at any point 2 meters from the vertical planes projected from the outer edges of the vehicle; and

- 17.15.10.4 0.02 mSv/h (2 millirem per hour) in any normally occupied positions of the vehicle, except that this provision does not apply to private motor carriers when persons occupying these positions are provided with special health supervision, personnel radiation exposure monitoring devices, and training in accordance with 10.3; and
- 17.15.11 For shipments made under the provisions of Section 17.15.10, the shipper shall provide specific written instructions to the carrier for maintenance of the exclusive use shipment controls. The instructions must be included with the shipping paper information.
- 17.15.12 The written instructions required for exclusive use shipments must be sufficient so that, when followed, they will cause the carrier to avoid actions that will:
- 17.15.12.1 Unnecessarily delay delivery; or
- 17.15.12.2 Unnecessarily result in increased radiation levels or radiation exposures to transport workers or members of the general public.
- 17.15.13 A package must be prepared for transport so that in still air at 100 degrees Fahrenheit (38 degrees Celsius) and in the shade, no accessible surface of a package would have a temperature exceeding 50 degrees Celsius (122 degrees Fahrenheit) in a nonexclusive use shipment or 82 degrees Celsius (185 degrees Fahrenheit) in an exclusive use shipment. Accessible package surface temperatures shall not exceed these limits at any time during transportation.
- 17.15.14 A package may not incorporate a feature intended to allow continuous venting during transport.
- 17.15.15 Before delivery of a package to a carrier for transport, the licensee shall ensure that any special instructions needed to safely open the package have been sent to the consignee, or otherwise made available to the consignee, for the consignee's use in accordance with 4.32.5.2.

REPORTS AND RECORDS

17.16 Reports.

The licensee shall report to the Department within 30 days:

- 17.16.1 Any instance in which there is significant reduction in the effectiveness of any packaging during use; and
- 17.16.2 Details of any defects with safety significance in the packaging after first use, with the means employed to repair the defects and prevent their recurrence; and
- 17.16.3 Instances in which the conditions of approval in the Certificate of Compliance were not observed in making a shipment.

17.17 Shipment Records.

- 17.17.1 Each licensee shall maintain, for a period of 3 years after shipment, a record of each shipment of licensed material not exempt under 17.4 showing, where applicable:
- 17.17.1.1 Identification of the packaging by model number and serial number;
- 17.17.1.2 Verification that the packaging, as shipped, had no significant defect;

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- 17.17.1.3 Volume and identification of coolant;
 - 17.17.1.4 Type and quantity of licensed material in each package, and the total quantity of each shipment;
 - 17.17.1.5 For each item of irradiated fissile material:
 - (1) Identification by model number and serial number;
 - (2) Irradiation and decay history to the extent appropriate to demonstrate that its nuclear and thermal characteristics comply with license conditions; and
 - (3) Any abnormal or unusual condition relevant to radiation safety;
 - 17.17.1.6 Date of the shipment;
 - 17.17.1.7 For fissile packages and for Type B packages, any special controls exercised;
 - 17.17.1.8 Name and address of the transferee;
 - 17.17.1.9 Address to which the shipment was made; and
 - 17.17.1.10 Results of the determinations required by 17.15 and by the conditions of the package approval.
- 17.17.2 The licensee shall make available to the Department for inspection, upon reasonable notice, all records required by this part. Records are only valid if stamped, initialed, or signed and dated by authorized personnel, or otherwise authenticated.
- 17.17.3 The licensee shall maintain sufficient written records to furnish evidence of the quality of packaging.
- 17.17.3.1 The records to be maintained shall include:
 - (1) Results of the determinations required by 10 CFR Part 71.85(a) through (c);
 - (2) Design, fabrication, and assembly records;
 - (3) Results of reviews, inspections, tests, and audits; results of monitoring work performance and materials analyses; and
 - (4) Results of maintenance, modification, and repair activities.
 - 17.17.3.2 Inspection, test, and audit records must identify:
 - (1) The inspector or data records,
 - (2) The type of observation,
 - (3) The results,
 - (4) The acceptability, and
 - (5) The action taken in connection with any deficiencies noted.
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17.17.3.3 The records required by 17.17.3. must be retained for 3 years after the life of the packaging to which they apply.

Appendix 17A - Determination of A₁ and A₂

17A1 Values of A₁ and A₂ for individual radionuclides, which are the bases for many activity limits elsewhere in these regulations are given in Table 17A1. The curie (Ci) values specified are obtained by converting from the Terabecquerel (TBq) value. The Terabecquerel values are the regulatory standard. The curie values are for information only and are not intended to be the regulatory standard. Where values of A₁ or A₂ are unlimited, it is for radiation control purposes only. For nuclear criticality safety, some materials are subject to controls placed on fissile material.

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

17A2.1 Not listed in Table 17A1:

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

17A2.2 Not listed in Table 17A2:

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

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

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

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

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

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

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

$$\sum_i \frac{B(i)}{A_2(i)} \leq 1$$

where B(i) is the activity of radionuclide i in normal form, and A₂(i) is the A₂ value for radionuclide i.

17A4.3 If the package contains both special and normal form radioactive materials, the activity that may be transported in a Type A package is as follows:

$$\sum_i \frac{B(i)}{A_1(i)} + \sum_j \frac{C(j)}{A_2(j)} \leq 1$$

Where B(i) is the activity of radionuclide i as special form radioactive material, A₁(i) is the A₁ value for radionuclide i, C(j) is the activity of radionuclide j as normal form radioactive material, and A₂(j) is the A₂ value for radionuclide j.

17A4.4 Alternatively, the A₁ value for mixtures of special form material may be determined as follows:

$$A_1 \text{ for mixture} = \frac{1}{\sum_i \frac{f(i)}{A_1(i)}}$$

where f(i) is the fraction of activity of nuclide i in the mixture and A₁(i) is the appropriate A₁ value for nuclide i.

17A4.5 Alternatively, the A₂ value for mixtures of normal form material may be determined as follows:

$$A_2 \text{ for mixture} = \frac{1}{\sum_i \frac{f(i)}{A_2(i)}}$$

where f(i) is the fraction of activity of nuclide i in the mixture and A₂(i) is the appropriate A₂ value for nuclide i.

17A4.6 The exempt activity concentration for mixtures of nuclides may be determined as follows:

$$\text{Exempt activity concentration for mixture} = \frac{1}{\sum_i \frac{f(i)}{[A](i)}}$$

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

17A4.7 The activity limit for an exempt consignment for mixtures of radionuclides may be determined as follows:

$$\text{Exempt consignment activity limit for mixture} = \frac{1}{\sum_i \frac{f(i)}{A(i)}}$$

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

- 17A5 When the identity of each radionuclide is known, but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest A_1 or A_2 value, as appropriate, for the radionuclides in each group may be used in applying the formulas in 17A4. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest A_1 or A_2 values for the alpha emitters and beta/gamma emitters.
- 17A6 When the identity of each radionuclide is known, but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest $[A]$ (activity concentration for exempt materials) or A (activity limit for exempt consignment) value, as appropriate, for the radionuclides in each group may be used in applying the formulas in 17A4. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest $[A]$ or A values for the alpha emitters and beta/gamma emitters, respectively.

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)b	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Ac-225 (a)	Actinium (89)	8.0X10 ⁻¹	2.2X10 ¹	6.0X10 ⁻³	1.6X10 ⁻¹	2.1X10 ³	5.8X10 ⁴
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
Au-198	.	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	9.0X10 ³	2.4X10 ⁵
Au-199	.	1.0X10 ¹	2.7X10 ²	6.0X10 ⁻¹	1.6X10 ¹	7.7X10 ³	2.1X10 ⁵
Ba-131 (a)	Barium (56)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	3.1X10 ³	8.4X10 ⁴
Ba-133	.	3.0	8.1X10 ¹	3.0	8.1X10 ¹	9.4	2.6X10 ²
Ba-133m	.	2.0X10 ¹	5.4X10 ²	6.0X10 ⁻¹	1.6X10 ¹	2.2X10 ⁴	6.1X10 ⁵
Ba-140 (a)	.	5.0X10 ⁻¹	1.4X10 ¹	3.0X10 ⁻¹	8.1	2.7X10 ³	7.3X10 ⁴
Be-7	Beryllium (4)	2.0X10 ¹	5.4X10 ²	2.0X10 ¹	5.4X10 ²	1.3X10 ⁴	3.5X10 ⁵
Be-10	.	4.0X10 ¹	1.1X10 ³	6.0X10 ⁻¹	1.6X10 ¹	8.3X10 ⁻⁴	2.2X10 ⁻²
Bi-205	Bismuth (83)	7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	1.5X10 ³	4.2X10 ⁴
Bi-206	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	3.8X10 ³	1.0X10 ⁵
Bi-207	.	7.0X10 ⁻¹	1.9X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	1.9	5.2X10 ¹
Bi-210	.	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	4.6X10 ³	1.2X10 ⁵
Bi-210m (a)	.	6.0X10 ⁻¹	1.6X10 ¹	2.0X10 ⁻²	5.4X10 ⁻¹	2.1X10 ⁻⁵	5.7X10 ⁻⁴
Bi-212 (a)	.	7.0X10 ⁻¹	1.9X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	5.4X10 ⁵	1.5X10 ⁷
Bk-247	Berkelium (97)	8.0	2.2X10 ²	8.0X10 ⁻⁴	2.2X10 ⁻²	3.8X10 ⁻²	1.0
Bk-249 (a)	.	4.0X10 ¹	1.1X10 ³	3.0X10 ⁻¹	8.1	6.1X10 ¹	1.6X10 ³

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES							
Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)b	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Br-76	Bromine (35)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	9.4X10 ⁴	2.5X10 ⁶
Br-77	.	3.0	8.1X10 ¹	3.0	8.1X10 ¹	2.6X10 ⁴	7.1X10 ⁵
Br-82	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁴	1.1X10 ⁶
C-11	Carbon (6)	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.1X10 ⁷	8.4X10 ⁸
C-14	.	4.0X10 ¹	1.1X10 ³	3.0	8.1X10 ¹	1.6X10 ⁻¹	4.5
Ca-41	Calcium (20)	Unlimited	Unlimited	Unlimited	Unlimited	3.1X10 ⁻³	8.5X10 ⁻²
Ca-45	.	4.0X10 ¹	1.1X10 ³	1.0	2.7X10 ¹	6.6X10 ²	1.8X10 ⁴
Ca-47 (a)	.	3.0	8.1X10 ¹	3.0X10 ⁻¹	8.1	2.3X10 ⁴	6.1X10 ⁵
Cd-109	Cadmium (48)	3.0X10 ¹	8.1X10 ²	2.0	5.4X10 ¹	9.6X10 ¹	2.6X10 ³
Cd-113m	.	4.0X10 ¹	1.1X10 ³	5.0X10 ⁻¹	1.4X10 ¹	8.3	2.2X10 ²
Cd-115 (a)	.	3.0	8.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.9X10 ⁴	5.1X10 ⁵
Cd-115m	.	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	9.4X10 ²	2.5X10 ⁴
Ce-139	Cerium (58)	7.0	1.9X10 ²	2.0	5.4X10 ¹	2.5X10 ²	6.8X10 ³
Ce-141	.	2.0X10 ¹	5.4X10 ²	6.0X10 ⁻¹	1.6X10 ¹	1.1X10 ³	2.8X10 ⁴
Ce-143	.	9.0X10 ⁻¹	2.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.5X10 ⁴	6.6X10 ⁵
Ce-144 (a)	.	2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	1.2X10 ²	3.2X10 ³
Cf-248	Californium (98)	4.0X10 ¹	1.1X10 ³	6.0X10 ⁻³	1.6X10 ⁻¹	5.8X10 ¹	1.6X10 ³
Cf-249	.	3.0	8.1X10 ¹	8.0X10 ⁻⁴	2.2X10 ⁻²	1.5X10 ⁻¹	4.1
Cf-250	.	2.0X10 ¹	5.4X10 ²	2.0X10 ⁻³	5.4X10 ⁻²	4.0	1.1X10 ²
Cf-251	.	7.0	1.9X10 ²	7.0X10 ⁻⁴	1.9X10 ⁻²	5.9X10 ⁻²	1.6
Cf-252	.	1.0X10 ⁻¹	2.7	3.0X10 ⁻³	8.1X10 ⁻²	2.0X10 ¹	5.4X10 ²
Cf-253 (a)	.	4.0X10 ¹	1.1X10 ³	4.0X10 ⁻²	1.1	1.1X10 ³	2.9X10 ⁴
Cf-254	.	1.0X10 ⁻³	2.7X10 ⁻²	1.0X10 ⁻³	2.7X10 ⁻²	3.1X10 ²	8.5X10 ³
Cl-36	Chlorine (17)	1.0X10 ¹	2.7X10 ²	6.0X10 ⁻¹	1.6X10 ¹	1.2X10 ⁻³	3.3X10 ⁻²
Cl-38	.	2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	4.9X10 ⁶	1.3X10 ⁸
Cm-240	Curium (96)	4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	7.5X10 ²	2.0X10 ⁴
Cm-241	.	2.0	5.4X10 ¹	1.0	2.7X10 ¹	6.1X10 ²	1.7X10 ⁴
Cm-242	.	4.0X10 ¹	1.1X10 ³	1.0X10 ⁻²	2.7X10 ⁻¹	1.2X10 ²	3.3X10 ³
Cm-243	.	9.0	2.4X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	1.9X10 ⁻³	5.2X10 ¹
Cm-244	.	2.0X10 ¹	5.4X10 ²	2.0X10 ⁻³	5.4X10 ⁻²	3.0	8.1X10 ¹
Cm-245	.	9.0	2.4X10 ²	9.0X10 ⁻⁴	2.4X10 ⁻²	6.4X10 ⁻³	1.7X10 ⁻¹
Cm-246	.	9.0	2.4X10 ²	9.0X10 ⁻⁴	2.4X10 ⁻²	1.1X10 ⁻²	3.1X10 ⁻¹
Cm-247 (a)	.	3.0	8.1X10 ¹	1.0X10 ⁻³	2.7X10 ⁻²	3.4X10 ⁻⁶	9.3X10 ⁻⁵
Cm-248	.	2.0X10 ⁻²	5.4X10 ⁻¹	3.0X10 ⁻⁴	8.1X10 ⁻³	1.6X10 ⁻⁴	4.2X10 ⁻³
Co-55	Cobalt (27)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	1.1X10 ⁵	3.1X10 ⁶
Co-56	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.1X10 ³	3.0X10 ⁴
Co-57	.	1.0X10 ¹	2.7X10 ²	1.0X10 ¹	2.7X10 ²	3.1X10 ²	8.4X10 ³
Co-58	.	1.0	2.7X10 ¹	1.0	2.7X10 ¹	1.2X10 ³	3.2X10 ⁴
Co-58m	.	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	2.2X10 ⁵	5.9X10 ⁶
Co-60	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	4.2X10 ¹	1.1X10 ³

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES							
Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)b	A ₂ (TBq)	A ₂ (Ci).	Specific activity	
						(TBq/g)	(Ci/g)
Cr-51	Chromium (24)	3.0X10 ⁻¹	8.1X10 ⁻²	3.0X10 ⁻¹	8.1X10 ⁻²	3.4X10 ⁻³	9.2X10 ⁻⁴
Cs-129	Cesium (55)	4.0	1.1X10 ⁻²	4.0	1.1X10 ⁻²	2.8X10 ⁻⁴	7.6X10 ⁻⁵
Cs-131	.	3.0X10 ⁻¹	8.1X10 ⁻²	3.0X10 ⁻¹	8.1X10 ⁻²	3.8X10 ⁻³	1.0X10 ⁻³
Cs-132	.	1.0	2.7X10 ⁻¹	1.0	2.7X10 ⁻¹	5.7X10 ⁻³	1.5X10 ⁻³
Cs-134	.	7.0X10 ⁻¹	1.9X10 ⁻¹	7.0X10 ⁻¹	1.9X10 ⁻¹	4.8X10 ⁻¹	1.3X10 ⁻³
Cs-134m	.	4.0X10 ⁻¹	1.1X10 ⁻³	6.0X10 ⁻¹	1.6X10 ⁻¹	3.0X10 ⁻⁵	8.0X10 ⁻⁶
Cs-135	.	4.0X10 ⁻¹	1.1X10 ⁻³	1.0	2.7X10 ⁻¹	4.3X10 ⁻⁵	1.2X10 ⁻³
Cs-136	.	5.0X10 ⁻¹	1.4X10 ⁻¹	5.0X10 ⁻¹	1.4X10 ⁻¹	2.7X10 ⁻³	7.3X10 ⁻⁴
Cs-137 (a)	.	2.0	5.4X10 ⁻¹	6.0X10 ⁻¹	1.6X10 ⁻¹	3.2	8.7X10 ⁻¹
Cu-64	Copper (29)	6.0	1.6X10 ⁻²	1.0	2.7X10 ⁻¹	1.4X10 ⁻⁵	3.9X10 ⁻⁶
Cu-67	.	1.0X10 ⁻¹	2.7X10 ⁻²	7.0X10 ⁻¹	1.9X10 ⁻¹	2.8X10 ⁻⁴	7.6X10 ⁻⁵
Dy-159	Dysprosium (66)	2.0X10 ⁻¹	5.4X10 ⁻²	2.0X10 ⁻¹	5.4X10 ⁻²	2.1X10 ⁻²	5.7X10 ⁻³
Dy-165	.	9.0X10 ⁻¹	2.4X10 ⁻¹	6.0X10 ⁻¹	1.6X10 ⁻¹	3.0X10 ⁻⁵	8.2X10 ⁻⁶
Dy-166 (a)	.	9.0X10 ⁻¹	2.4X10 ⁻¹	3.0X10 ⁻¹	8.1	8.6X10 ⁻³	2.3X10 ⁻⁵
Er-169	Erbium (68)	4.0X10 ⁻¹	1.1X10 ⁻³	1.0	2.7X10 ⁻¹	3.1X10 ⁻³	8.3X10 ⁻⁴
Er-171	.	8.0X10 ⁻¹	2.2X10 ⁻¹	5.0X10 ⁻¹	1.4X10 ⁻¹	9.0X10 ⁻⁴	2.4X10 ⁻⁶
Eu-147	Europium (63)	2.0	5.4X10 ⁻¹	2.0	5.4X10 ⁻¹	1.4X10 ⁻³	3.7X10 ⁻⁴
Eu-148	.	5.0X10 ⁻¹	1.4X10 ⁻¹	5.0X10 ⁻¹	1.4X10 ⁻¹	6.0X10 ⁻²	1.6X10 ⁻⁴
Eu-149	.	2.0X10 ⁻¹	5.4X10 ⁻²	2.0X10 ⁻¹	5.4X10 ⁻²	3.5X10 ⁻²	9.4X10 ⁻³
Eu-150. (short.lived)	.	2.0	5.4X10 ⁻¹	7.0X10 ⁻¹	1.9X10 ⁻¹	6.1X10 ⁻⁴	1.6X10 ⁻⁶
Eu-150. (long.lived)	.	7.0X10 ⁻¹	1.9X10 ⁻¹	7.0X10 ⁻¹	1.9X10 ⁻¹	6.1X10 ⁻⁴	1.6X10 ⁻⁶
Eu-152	.	1.0	2.7X10 ⁻¹	1.0	2.7X10 ⁻¹	6.5	1.8X10 ⁻²
Eu-152m	.	8.0X10 ⁻¹	2.2X10 ⁻¹	8.0X10 ⁻¹	2.2X10 ⁻¹	8.2X10 ⁻⁴	2.2X10 ⁻⁶
Eu-154	.	9.0X10 ⁻¹	2.4X10 ⁻¹	6.0X10 ⁻¹	1.6X10 ⁻¹	9.8	2.6X10 ⁻²
Eu-155	.	2.0X10 ⁻¹	5.4X10 ⁻²	3.0	8.1X10 ⁻¹	1.8X10 ⁻¹	4.9X10 ⁻²
Eu-156	.	7.0X10 ⁻¹	1.9X10 ⁻¹	7.0X10 ⁻¹	1.9X10 ⁻¹	2.0X10 ⁻³	5.5X10 ⁻⁴
F-18	Fluorine.(9)	1.0	2.7X10 ⁻¹	6.0X10 ⁻¹	1.6X10 ⁻¹	3.5X10 ⁻⁶	9.5X10 ⁻⁷
Fe-52.(a)	Iron.(26)	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	2.7X10 ⁻⁵	7.3X10 ⁻⁶
Fe-55	.	4.0X10 ⁻¹	1.1X10 ⁻³	4.0X10 ⁻¹	1.1X10 ⁻³	8.8X10 ⁻¹	2.4X10 ⁻³
Fe-59	.	9.0X10 ⁻¹	2.4X10 ⁻¹	9.0X10 ⁻¹	2.4X10 ⁻¹	1.8X10 ⁻³	5.0X10 ⁻⁴
Fe-60 (a)	.	4.0X10 ⁻¹	1.1X10 ⁻³	2.0X10 ⁻¹	5.4	7.4X10 ⁻⁴	2.0X10 ⁻²
Ga-67	Gallium (31)	7.0	1.9X10 ⁻²	3.0	8.1X10 ⁻¹	2.2X10 ⁻⁴	6.0X10 ⁻⁵
Ga-68	.	5.0X10 ⁻¹	1.4X10 ⁻¹	5.0X10 ⁻¹	1.4X10 ⁻¹	1.5X10 ⁻⁶	4.1X10 ⁻⁷
Ga-72	.	4.0X10 ⁻¹	1.1X10 ⁻¹	4.0X10 ⁻¹	1.1X10 ⁻¹	1.1X10 ⁻⁵	3.1X10 ⁻⁶
Gd-146.(a)	Gadolinium(64)	5.0X10 ⁻¹	1.4X10 ⁻¹	5.0X10 ⁻¹	1.4X10 ⁻¹	6.9X10 ⁻²	1.9X10 ⁻⁴
Gd-148	.	2.0X10 ⁻¹	5.4X10 ⁻²	2.0X10 ⁻³	5.4X10 ⁻²	1.2	3.2X10 ⁻¹
Gd-153	.	1.0X10 ⁻¹	2.7X10 ⁻²	9.0	2.4X10 ⁻²	1.3X10 ⁻²	3.5X10 ⁻³
Gd-159	.	3.0	8.1X10 ⁻¹	6.0X10 ⁻¹	1.6X10 ⁻¹	3.9X10 ⁻⁴	1.1X10 ⁻⁶
Ge-68.(a)	Germanium(32)	5.0X10 ⁻¹	1.4X10 ⁻¹	5.0X10 ⁻¹	1.4X10 ⁻¹	2.6X10 ⁻²	7.1X10 ⁻³

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES							
Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)b	A ₂ (TBq)	A ₂ (Ci).	Specific activity	
						(TBq/g)	(Ci/g)
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-197m	.	1.0X10 ¹	2.7X10 ²	4.0X10 ⁻¹	1.1X10 ¹	2.5X10 ⁴	6.7X10 ⁵
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	^c 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
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-79	Krypton (36)	4.0	1.1X10 ²	2.0	5.4X10 ¹	4.2X10 ⁴	1.1X10 ⁶
Kr-81	.	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

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES							
Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)b	A ₂ (TBq)	A ₂ (Ci).	Specific activity	
						(TBq/g)	(Ci/g)
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) (h)	.	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.8X10 ⁴	4.8X10 ⁵
N-13	Nitrogen (7)	9.0X10 ⁻¹	2.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	5.4X10 ⁷	1.5X10 ⁹
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-194 (a)	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.1X10 ¹	3.1X10 ²
P-32	Phosphorus. (15)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	1.1X10 ⁴	2.9X10 ⁵
P-33	.	4.0X10 ¹	1.1X10 ³	1.0	2.7X10 ¹	5.8X10 ³	1.6X10 ⁵

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES							
Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)b	A ₂ (TBq)	A ₂ (Ci).	Specific activity	
						(TBq/g)	(Ci/g)
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	.	4.0X10 ¹	1.1X10 ³	2.0	5.4X10 ¹	3.4X10 ¹	9.3X10 ²
Pm-148m. (a)	.	8.0X10 ⁻¹	2.2X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	7.9X10 ²	2.1X10 ⁴
Pm-149	.	2.0	5.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.5X10 ⁴	4.0X10 ⁵
Pm-151	.	2.0	5.4X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.7X10 ⁴	7.3X10 ⁵
Po-210	Polonium. (84)	4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	1.7X10 ²	4.5X10 ³
Pr-142	Praseodymium. (59)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	4.3X10 ⁴	1.2X10 ⁶
Pr-143	.	3.0	8.1X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.5X10 ³	6.7X10 ⁴
Pt-188. (a)	Platinum. (78)	1.0	2.7X10 ¹	8.0X10 ⁻¹	2.2X10 ¹	2.5X10 ³	6.8X10 ⁴
Pt-191	.	4.0	1.1X10 ²	3.0	8.1X10 ¹	8.7X10 ³	2.4X10 ⁵
Pt-193	.	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	1.4	3.7X10 ¹
Pt-193m	.	4.0X10 ¹	1.1X10 ³	5.0X10 ⁻¹	1.4X10 ¹	5.8X10 ³	1.6X10 ⁵
Pt-195m	.	1.0X10 ¹	2.7X10 ²	5.0X10 ⁻¹	1.4X10 ¹	6.2X10 ³	1.7X10 ⁵
Pt-197	.	2.0X10 ¹	5.4X10 ²	6.0X10 ⁻¹	1.6X10 ¹	3.2X10 ⁴	8.7X10 ⁵
Pt-197m	.	1.0X10 ¹	2.7X10 ²	6.0X10 ⁻¹	1.6X10 ¹	3.7X10 ⁵	1.0X10 ⁷
Pu-236	Plutonium. (94)	3.0X10 ¹	8.1X10 ²	3.0X10 ⁻³	8.1X10 ⁻²	2.0X10 ¹	5.3X10 ²
Pu-237	.	2.0X10 ¹	5.4X10 ²	2.0X10 ¹	5.4X10 ²	4.5X10 ²	1.2X10 ⁴
Pu-238	.	1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	6.3X10 ⁻¹	1.7X10 ¹
Pu-239	.	1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	2.3X10 ⁻³	6.2X10 ⁻²
Pu-240	.	1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	8.4X10 ⁻³	2.3X10 ⁻¹
Pu-241. (a)	.	4.0X10 ¹	1.1X10 ³	6.0X10 ⁻²	1.6	3.8	1.0X10 ²
Pu-242	.	1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	1.5X10 ⁻⁴	3.9X10 ⁻³
Pu-244. (a)	.	4.0X10 ⁻¹	1.1X10 ¹	1.0X10 ⁻³	2.7X10 ⁻²	6.7X10 ⁻⁷	1.8X10 ⁻⁵
Ra-223. (a)	Radium. (88)	4.0X10 ⁻¹	1.1X10 ¹	7.0X10 ⁻³	1.9X10 ⁻¹	1.9X10 ³	5.1X10 ⁴

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES							
Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)b	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
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
Rh-102m	.	2.0	5.4X10 ¹	2.0	5.4X10 ¹	2.3X10 ²	6.2X10 ³
Rh-103m	.	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	1.2X10 ⁶	3.3X10 ⁷
Rh-105	.	1.0X10 ¹	2.7X10 ²	8.0X10 ⁻¹	2.2X10 ¹	3.1X10 ⁴	8.4X10 ⁵
Rn-222. (a)	Radon (86)	3.0X10 ⁻¹	8.1	4.0X10 ⁻³	1.1X10 ⁻¹	5.7X10 ³	1.5X10 ⁵
Ru-97	Ruthenium (44)	5.0	1.4X10 ²	5.0	1.4X10 ²	1.7X10 ⁴	4.6X10 ⁵
Ru-103. (a)	.	2.0	5.4X10 ¹	2.0	5.4X10 ¹	1.2X10 ³	3.2X10 ⁴
Ru-105	.	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.5X10 ⁵	6.7X10 ⁶
Ru-106. (a)	.	2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	1.2X10 ²	3.3X10 ³
S-35	Sulphur (16)	4.0X10 ¹	1.1X10 ³	3.0	8.1X10 ¹	1.6X10 ³	4.3X10 ⁴
Sb-122	Antimony (51)	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.5X10 ⁴	4.0X10 ⁵
Sb-124	.	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	6.5X10 ²	1.7X10 ⁴
Sb-125	.	2.0	5.4X10 ¹	1.0	2.7X10 ¹	3.9X10 ¹	1.0X10 ³
Sb-126	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	3.1X10 ³	8.4X10 ⁴
Sc-44	Scandium (21)	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	6.7X10 ⁵	1.8X10 ⁷
Sc-46	.	5.0X10 ⁻¹	1.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	1.3X10 ³	3.4X10 ⁴
Sc-47	.	1.0X10 ¹	2.7X10 ²	7.0X10 ⁻¹	1.9X10 ¹	3.1X10 ⁴	8.3X10 ⁵
Sc-48	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	5.5X10 ⁴	1.5X10 ⁶
Se-75	Selenium (34)	3.0	8.1X10 ¹	3.0	8.1X10 ¹	5.4X10 ²	1.5X10 ⁴
Se-79	.	4.0X10 ¹	1.1X10 ³	2.0	5.4X10 ¹	2.6X10 ⁻³	7.0X10 ⁻²
Si-31	Silicon (14)	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.4X10 ⁶	3.9X10 ⁷

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES							
Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)b	A ₂ (TBq)	A ₂ (Ci).	Specific activity	
						(TBq/g)	(Ci/g)
Si-32	.	4.0X10 ¹	1.1X10 ³	5.0X10 ⁻¹	1.4X10 ¹	3.9	1.1X10 ²
Sm-145	Samarium (62)	1.0X10 ¹	2.7X10 ²	1.0X10 ¹	2.7X10 ²	9.8X10 ¹	2.6X10 ³
Sm-147	.	Unlimited	Unlimited	Unlimited	Unlimited	8.5X10 ⁻¹⁰	2.3X10 ⁻⁸
Sm-151	.	4.0X10 ¹	1.1X10 ³	1.0X10 ¹	2.7X10 ²	9.7X10 ⁻¹	2.6X10 ¹
Sm-153	.	9.0	2.4X10 ²	6.0X10 ⁻¹	1.6X10 ¹	1.6X10 ⁴	4.4X10 ⁵
Sn-113. (a)	Tin (50)	4.0	1.1X10 ²	2.0	5.4X10 ¹	3.7X10 ²	1.0X10 ⁴
Sn-117m	.	7.0	1.9X10 ²	4.0X10 ⁻¹	1.1X10 ¹	3.0X10 ³	8.2X10 ⁴
Sn-119m	.	4.0X10 ¹	1.1X10 ³	3.0X10 ¹	8.1X10 ²	1.4X10 ²	3.7X10 ³
Sn-121m. (a)	.	4.0X10 ¹	1.1X10 ³	9.0X10 ⁻¹	2.4X10 ¹	2.0	5.4X10 ¹
Sn-123	.	8.0X10 ⁻¹	2.2X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	3.0X10 ²	8.2X10 ³
Sn-125	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ³	1.1X10 ⁵
Sn-126. (a)	.	6.0X10 ⁻¹	1.6X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.0X10 ⁻³	2.8X10 ⁻²
Sr-82 . (a)	Strontium (38)	2.0X10 ⁻¹	5.4	2.0X10 ⁻¹	5.4	2.3X10 ³	6.2X10 ⁴
Sr-85	.	2.0	5.4X10 ¹	2.0	5.4X10 ¹	8.8X10 ²	2.4X10 ⁴
Sr-85m	.	5.0	1.4X10 ²	5.0	1.4X10 ²	1.2X10 ⁶	3.3X10 ⁷
Sr-87m	.	3.0	8.1X10 ¹	3.0	8.1X10 ¹	4.8X10 ⁵	1.3X10 ⁷
Sr-89	.	6.0X10 ⁻¹	1.6X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	1.1X10 ³	2.9X10 ⁴
Sr-90. (a)	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	5.1	1.4X10 ²
Sr-91. (a)	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.3X10 ⁵	3.6X10 ⁶
Sr-92. (a)	.	1.0	2.7X10 ¹	3.0X10 ⁻¹	8.1	4.7X10 ⁵	1.3X10 ⁷
T(H-3)	Tritium. (1)	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	3.6X10 ²	9.7X10 ³
Ta-178. (long	Tantalum. (73)	1.0	2.7X10 ¹	8.0X10 ⁻¹	2.2X10 ¹	4.2X10 ⁶	1.1X10 ⁸
Ta-179	.	3.0X10 ¹	8.1X10 ²	3.0X10 ¹	8.1X10 ²	4.1X10 ¹	1.1X10 ³
Ta-182	.	9.0X10 ⁻¹	2.4X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	2.3X10 ²	6.2X10 ³
Tb-157	Terbium. (65)	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	5.6X10 ⁻¹	1.5X10 ¹
Tb-158	.	1.0	2.7X10 ¹	1.0	2.7X10 ¹	5.6X10 ⁻¹	1.5X10 ¹
Tb-160	.	1.0	2.7X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	4.2X10 ²	1.1X10 ⁴
Tc-95m (a)	Technetium (43)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	8.3X10 ²	2.2X10 ⁴
Tc-96	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.2X10 ⁴	3.2X10 ⁵
Tc-96m. (a)	.	4.0X10 ⁻¹	1.1X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.4X10 ⁶	3.8X10 ⁷
Tc-97	.	Unlimited	Unlimited	Unlimited	Unlimited	5.2X10 ⁻⁵	1.4X10 ⁻³
Tc-97m	.	4.0X10 ¹	1.1X10 ³	1.0	2.7X10 ¹	5.6X10 ²	1.5X10 ⁴
Tc-98	.	8.0X10 ⁻¹	2.2X10 ¹	7.0X10 ⁻¹	1.9X10 ¹	3.2X10 ⁻⁵	8.7X10 ⁻⁴
Tc-99	.	4.0X10 ¹	1.1X10 ³	9.0X10 ⁻¹	2.4X10 ¹	6.3X10 ⁻⁴	1.7X10 ⁻²
Tc-99m	.	1.0X10 ¹	2.7X10 ²	4.0	1.1X10 ²	1.9X10 ⁵	5.3X10 ⁶
Te-121	Tellurium. (52)	2.0	5.4X10 ¹	2.0	5.4X10 ¹	2.4X10 ³	6.4X10 ⁴

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)b	A ₂ (TBq)	A ₂ (Ci).	Specific activity	
						(TBq/g)	(Ci/g)
Te-121m	.	5.0	1.4X10 ²	3.0	8.1X10 ¹	2.6X10 ²	7.0X10 ³
Te-123m	.	8.0	2.2X10 ²	1.0	2.7X10 ¹	3.3X10 ²	8.9X10 ³
Te-125m	.	2.0X10 ¹	5.4X10 ²	9.0X10 ⁻¹	2.4X10 ¹	6.7X10 ²	1.8X10 ⁴
Te-127	.	2.0X10 ¹	5.4X10 ²	7.0X10 ⁻¹	1.9X10 ¹	9.8X10 ⁴	2.6X10 ⁶
Te-127m. (a)	.	2.0X10 ¹	5.4X10 ²	5.0X10 ⁻¹	1.4X10 ¹	3.5X10 ²	9.4X10 ³
Te-129	.	7.0X10 ⁻¹	1.9X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	7.7X10 ⁵	2.1X10 ⁷
Te-129m. (a)	.	8.0X10 ⁻¹	2.2X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.1X10 ³	3.0X10 ⁴
Te-131m. (a)	.	7.0X10 ⁻¹	1.9X10 ¹	5.0X10 ⁻¹	1.4X10 ¹	3.0X10 ⁴	8.0X10 ⁵
Te-132. (a)	.	5.0X10 ⁻¹	1.4X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	1.1X10 ⁴	3.0X10 ⁵
Th-227	Thorium. (90)	1.0X10 ¹	2.7X10 ²	5.0X10 ⁻³	1.4X10 ⁻¹	1.1X10 ³	3.1X10 ⁴
Th-228. (a)	.	5.0X10 ⁻¹	1.4X10 ¹	1.0X10 ⁻³	2.7X10 ⁻²	3.0X10 ¹	8.2X10 ²
Th-229	.	5.0	1.4X10 ²	5.0X10 ⁻⁴	1.4X10 ⁻²	7.9X10 ⁻³	2.1X10 ⁻¹
Th-230	.	1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	7.6X10 ⁻⁴	2.1X10 ⁻²
Th-231	.	4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	2.0X10 ⁴	5.3X10 ⁵
Th-232	.	Unlimited	Unlimited	Unlimited	Unlimited	4.0X10 ⁻⁹	1.1X10 ⁻⁷
Th-234. (a)	.	3.0X10 ⁻¹	8.1	3.0X10 ⁻¹	8.1	8.6X10 ²	2.3X10 ⁴
Th(nat)	.	Unlimited	Unlimited	Unlimited	Unlimited	8.1X10 ⁻⁹	2.2X10 ⁻⁷
Ti-44. (a)	Titanium. (22)	5.0X10 ⁻¹	1.4X10 ¹	4.0X10 ⁻¹	1.1X10 ¹	6.4	1.7X10 ²
Tl-200	Thallium. (81)	9.0X10 ⁻¹	2.4X10 ¹	9.0X10 ⁻¹	2.4X10 ¹	2.2X10 ⁴	6.0X10 ⁵
Tl-201	.	1.0X10 ¹	2.7X10 ²	4.0	1.1X10 ²	7.9X10 ³	2.1X10 ⁵
Tl-202	.	2.0	5.4X10 ¹	2.0	5.4X10 ¹	2.0X10 ³	5.3X10 ⁴
Tl-204	.	1.0X10 ¹	2.7X10 ²	7.0X10 ⁻¹	1.9X10 ¹	1.7X10 ¹	4.6X10 ²
Tm-167	Thulium. (69)	7.0	1.9X10 ²	8.0X10 ⁻¹	2.2X10 ¹	3.1X10 ³	8.5X10 ⁴
Tm-170	.	3.0	8.1X10 ¹	6.0X10 ⁻¹	1.6X10 ¹	2.2X10 ²	6.0X10 ³
Tm-171	.	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³	4.0X10 ¹	1.1X10 ³
U-230. (fast. lung. absorption). (a)(d)	Uranium. (92)	4.0X10 ¹	1.1X10 ³	1.0X10 ⁻¹	2.7	1.0X10 ³	2.7X10 ⁴
U-230. (medium. lung. absorption). (a)(e)	.	4.0X10 ¹	1.1X10 ³	4.0X10 ⁻³	1.1X10 ⁻¹	1.0X10 ³	2.7X10 ⁴
U-230 (slow lung absorption) (a)(f)	.	3.0X10 ¹	8.1X10 ²	3.0X10 ⁻³	8.1X10 ⁻²	1.0X10 ³	2.7X10 ⁴
U-232. (fast. lung. absorption). (d)	.	4.0X10 ¹	1.1X10 ³	1.0X10 ⁻²	2.7X10 ⁻¹	8.3X10 ⁻¹	2.2X10 ¹

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES							
Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)b	A ₂ (TBq)	A ₂ (Ci).	Specific activity	
						(TBq/g)	(Ci/g)
U-232. (medium. lung . absorption). (e)	.	4.0X10 ¹	1.1X10 ³	7.0X10 ⁻³	1.9X10 ⁻¹	8.3X10 ⁻¹	2.2X10 ¹
U-232. (slow. lung. absorption). (f)	.	1.0X10 ¹	2.7X10 ²	1.0X10 ⁻³	2.7X10 ⁻²	8.3X10 ⁻¹	2.2X10 ¹
U-233. (fast. lung. absorption). (d)	.	4.0X10 ¹	1.1X10 ³	9.0X10 ⁻²	2.4	3.6X10 ⁻⁴	9.7X10 ⁻³
U-233. (medium. lung. absorption). (e)	.	4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	3.6X10 ⁻⁴	9.7X10 ⁻³
U-233. (slow. lung. absorption). (f)	.	4.0X10 ¹	1.1X10 ³	6.0X10 ⁻³	1.6X10 ⁻¹	3.6X10 ⁻⁴	9.7X10 ⁻³
U-234. (fast. lung. absorption)(d)	.	4.0X10 ¹	1.1X10 ³	9.0X10 ⁻²	2.4	2.3X10 ⁻⁴	6.2X10 ⁻³
U-234 (medium lung absorption) (e)	.	4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	2.3X10 ⁻⁴	6.2X10 ⁻³
U-234 (slow lung absorption) (f)	.	4.0X10 ¹	1.1X10 ³	6.0X10 ⁻³	1.6X10 ⁻¹	2.3X10 ⁻⁴	6.2X10 ⁻³
U-235. (all. lung. absorption. types). (a),(d),(e),(f)	.	Unlimited	Unlimited	Unlimited	Unlimited	8.0X10 ⁻⁸	2.2X10 ⁻⁶
U-236. (fast. lung. absorption). (d)	.	Unlimited	Unlimited	Unlimited	Unlimited	2.4X10 ⁻⁶	6.5X10 ⁻⁵
U-236. (medium. lung . absorption). (e)	.	4.0X10 ¹	1.1X10 ³	2.0X10 ⁻²	5.4X10 ⁻¹	2.4X10 ⁻⁶	6.5X10 ⁻⁵
U-236 (slow lung absorption) (f)	.	4.0X10 ¹	1.1X10 ³	6.0X10 ⁻³	1.6X10 ⁻¹	2.4X10 ⁻⁶	6.5X10 ⁻⁵
U-238 . (all lung absorption types) (d),(e),(f)	.	Unlimited	Unlimited	Unlimited	Unlimited	1.2X10 ⁻⁸	3.4X10 ⁻⁷
U. (nat)	.	Unlimited	Unlimited	Unlimited	Unlimited	2.6X10 ⁻⁸	7.1X10 ⁻⁷
U. (enriched. to. 20%. or. less). (g)	.	Unlimited	Unlimited	Unlimited	Unlimited	See. Table. 17A4	See. Table. 17A4
U. (dep)	.	Unlimited	Unlimited	Unlimited	Unlimited	See. Table. 17A4	(See. Table. 17A3)
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

TABLE 17A1: A1 AND A2 VALUES FOR RADIONUCLIDES							
Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci) ^b	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
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 ⁻¹	8.1	3.0X10 ⁻¹	8.1	1.2X10 ⁻⁵	3.3X10 ⁻⁶
Yb-169	Ytterbium. (70)	4.0	1.1X10 ⁻²	1.0	2.7X10 ⁻¹	8.9X10 ⁻²	2.4X10 ⁻⁴
Yb-175	.	3.0X10 ⁻¹	8.1X10 ⁻²	9.0X10 ⁻¹	2.4X10 ⁻¹	6.6X10 ⁻³	1.8X10 ⁻⁵
Zn-65	Zinc. (30)	2.0	5.4X10 ⁻¹	2.0	5.4X10 ⁻¹	3.0X10 ⁻²	8.2X10 ⁻³
Zn-69	.	3.0	8.1X10 ⁻¹	6.0X10 ⁻¹	1.6X10 ⁻¹	1.8X10 ⁻⁶	4.9X10 ⁻⁷
Zn-69m. (a)	.	3.0	8.1X10 ⁻¹	6.0X10 ⁻¹	1.6X10 ⁻¹	1.2X10 ⁻⁵	3.3X10 ⁻⁶
Zr-88	Zirconium. (40)	3.0	8.1X10 ⁻¹	3.0	8.1X10 ⁻¹	6.6X10 ⁻²	1.8X10 ⁻⁴
Zr-93	.	Unlimited	Unlimited	Unlimited	Unlimited	9.3X10 ⁻⁵	2.5X10 ⁻³
Zr-95. (a)	.	2.0	5.4X10 ⁻¹	8.0X10 ⁻¹	2.2X10 ⁻¹	7.9X10 ⁻²	2.1X10 ⁻⁴
Zr-97. (a)	.	4.0X10 ⁻¹	1.1X10 ⁻¹	4.0X10 ⁻¹	1.1X10 ⁻¹	7.1X10 ⁻⁴	1.9X10 ⁻⁶

Notes:

a A1 and/or A2 values include contributions from daughter nuclides with half-lives less than 10 days, as listed in the following:

Mg-28	Al-28
Ca-47	Sc-47
Ti-44	Sc-44
Fe-52	Mn-52m
Fe-60	Co-60m
Zn-69m	Zn-69
Ge-68	Ga-68
Rb-83	Kr-83m
Sr-82	Rb-82
Sr-90	Y-90

Sr-91	Y-91m
Sr-92	Y-92
Y-87	Sr-87m
Zr-95	Nb-95m
Zr-97	Nb-97m, Nb-97
Mo-99	Tc-99m
Tc-95m	Tc-95
Tc-96m	Tc-96
Ru-103	Rh-103m
Ru-106	Rh-106
Pd-103	Rh-103m
Ag-108m	Ag-108
Ag-110m	Ag-110
Cd-115	In-115m
In-114m	In-114
Sn-113	In-113m
Sn-121m	Sn-121
Sn-126	Sb-126m
Te-127m	Te-127
Te-129m	Te-129
Te-131m	Te-131
Te-132	I-132
I-135	Xe-135m
Xe-122	I-122
Cs-137	Ba-137m
Ba-131	Cs-131
Ba-140	La-140
Ce-144	Pr-144m, Pr-144
Pm-148m	Pm-148
Gd-146	Eu-146
Dy-166	Ho-166
Hf-172	Lu-172
W-178	Ta-178
W-188	Re-188
Re-189	Os-189m
Os-194	Ir-194
Ir-189	Os-189m
Pt-188	Ir-188
Hg-194	Au-194
Hg-195m	Hg-195
Pb-210	Bi-210
Pb-212	Bi-212, Tl-208, Po-212
Bi-210m	Tl-206
Bi-212	Tl-208, Po-212
At-211	Po-211
Rn-222	Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Ra-225	Ac-225, Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ra-226	Rn-222, Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-228	Ac-228
Ac-225	Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ac-227	Fr-223
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Th-234	Pa-234m, Pa-234
Pa-230	Ac-226, Th-226, Fr-222, Ra-222, Rn-218, Po-214
U-230	Th-226, Ra-222, Rn-218, Po-214
U-235	Th-231
Pu-241	U-237
Pu-244	U-240, Np-240m
Am-242m	Am-242, Np-238
Am-243	Np-239
Cm-247	Pu-243
Bk-249	Am-245
Cf-253	Cm-249

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)

c The activity of Ir-192 in special form may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed distance from the source.

- d These values apply only to compounds of uranium that take the chemical form of UF₆, UO₂F₂ and UO₂(NO₃)₂ in both normal and accident conditions of transport.
- e These values apply only to compounds of uranium that take the chemical form of UO₃, UF₄, UCl₄, and hexavalent compounds in both normal and accident conditions of transport.
- f These values apply to all compounds of uranium other than those specified in d and e, above.
- g These values apply to unirradiated uranium only.
- h A₂ = 0.74 TBq (20 Ci) for Mo-99 for domestic use.

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

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Ac-225	Actinium (89)	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Ac-227	.	1.0×10^{-1}	2.7×10^{-12}	1.0×10^3	2.7×10^{-8}
Ac-228	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Ag-105	Silver (47)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Ag-108m (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Ag-110m	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Ag-111	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Al-26	Aluminum (13)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Am-241	Americium (95)	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Am-242m (a)	.	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Am-243 (a)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Ar-37	Argon (18)	1.0×10^6	2.7×10^{-5}	1.0×10^8	2.7×10^{-3}
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 (33)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
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	Astatine (85)	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Au-193	Gold (79)	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
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 (56)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
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 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Be-7	Beryllium (4)	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Be-10	.	1.0×10^4	2.7×10^{-7}	1.0×10^6	2.7×10^{-5}
Bi-205	Bismuth (83)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
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}
Bi-212 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES					
Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Bk-247	Berkelium (97)	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Bk-249	.	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	.	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}
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 (a)	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
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	.	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}
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}
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}

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES					
Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
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}
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}
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 (short-lived)	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Eu-150 (long-lived)	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
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	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	.	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}
Gd-148	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES					
Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
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	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}
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}
Hg-195m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
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}
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	.	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}
In-115m	.	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Ir-189	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-79	Krypton (36)	1.0×10^3	2.7×10^{-8}	1.0×10^5	2.7×10^{-6}
Kr-81	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES					
Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
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	Magnesium (12)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Mn-52	Manganese (25)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
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	.	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 (a)	.	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}

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES					
Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Os-194	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	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	.	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	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}
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}

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES					
Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Pu-241	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
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}
Ra-223 (a)	Radium (88)	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Ra-224 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Ra-225	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Ra-226 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Ra-228 (a)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Rb-81	Rubidium (37)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Rb-83	.	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 (natural)	.	1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Re-184	Rhenium (75)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
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}
Re (natural)	.	1.0×10^6	2.7×10^{-5}	1.0×10^9	2.7×10^{-2}
Rh-99	Rhodium (45)	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
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 (a)	Radon (86)	1.0×10^1	2.7×10^{-10}	1.0×10^8	2.7×10^{-3}
Ru-97	Ruthenium (44)	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}
Ru-103	.	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}

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES					
Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
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	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	.	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	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Sr-82	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}
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	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Sr-92	.	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	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	.	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}

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES					
Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
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}	1.0×10^6	2.7×10^{-5}
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	.	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	.	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Te-131m	.	1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Te-132	.	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}
Th-229 (a)	.	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) (a)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
Ti-44	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),(b)	Uranium (92)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
U-230 (medium lung absorption) (c)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
U-230 (slow lung absorption) (d)	.	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
U-232 (fast lung absorption) (a),(b)	Uranium (92)	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U-232 (medium lung absorption) (c)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U-232 (slow lung absorption) (d)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U-233 (fast lung absorption) (b)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES					
Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
U-233 (medium lung absorption) (c)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-233 (slow lung absorption) (d)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-234 (fast lung absorption) (b)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-234 (medium lung absorption) (c)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-234 (slow lung absorption) (d)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-235 (all lung absorption types) (a),(b),(c),(d)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-236 (fast lung absorption) (b)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-236 (medium lung absorption) (c)	Uranium (92)	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-236 (slow lung absorption) (d)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-238 (all lung absorption types) (a),(b),(c),(d)	.	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U (natural) (a)	.	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U (enriched to 20% or less) (e)	.	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	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	.	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Xe-122	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	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}

TABLE 17A2: EXEMPT MATERIAL ACTIVITY CONCENTRATIONS AND EXEMPT CONSIGNMENT ACTIVITY LIMITS FOR RADIONUCLIDES					
Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
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	.	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 (a)	.	1.0×10^3	2.7×10^{-8}	1.0×10^7	2.7×10^{-4}
Zr-95	.	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}

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

Sr-90	Y-90
Zr-93	Nb-93m
Zr-97	Nb-97
Ru-106	Rh-106
Ag-108m	Ag-108
Cs-137	Ba-137m
Ce-144	Pr-144
Ba-140	La-140
Bi-212	Tl-208 (0.36), Po-212 (0.64)
Pb-210	Bi-210, Po-210
Pb-212	Bi-212, Tl-208 (0.36), Po-212 (0.64)
Rn-222	Po-218, Pb-214, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Ra-228	Ac-228
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-229	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
Th-nat	Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-234	Pa-234m
U-230	Th-226, Ra-222, Rn-218, Po-214
U-232	Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
U-235	Th-231
U-238	Th-234, Pa-234m

U-nat	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Np-237	Pa-233
Am-242m	Am-242
Am-243	Np-239

b These values apply only to compounds of uranium that take the chemical form of UF₆, UO₂F₂ and UO₂(NO₃)₂ in both normal and accident conditions of transport.

c These values apply only to compounds of uranium that take the chemical form of UO₃, UF₄, UCl₄, and hexavalent compounds in both normal and accident conditions of transport.

d These values apply to all compounds of uranium other than those specified in b and c, above.

e These values apply to unirradiated uranium only.

TABLE 17A3: GENERAL VALUES FOR A1 AND A2

Contents	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limits for exempt consignments (Bq)	Activity limits for exempt consignments (Ci)
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}
Alpha emitting radionuclides, but no neutron emitters, are known to be present (a)	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}
Neutron emitting nuclides are known to be present or 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}

a If beta or gamma emitting nuclides are known to be present, the A1 value of 0.1 TBq (2.7 Ci) should be used.

TABLE 17A4: ACTIVITY-MASS RELATIONSHIPS FOR URANIUM

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

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

Editor's Notes

6 CCR 1007-1 has been divided into separate parts for ease of use. Versions prior to 04/01/2007 are located in the first section, 6 CCR 1007-1. Prior versions can be accessed from the All Versions list on the rule's current version page. To view versions effective on or after 04/01/2007, select the desired part of the rule, for example 6 CCR 1007-1 Part 01 or 6 CCR 1007-1 Part 10.

History

Part 17 entire rule eff. 08/30/2007.

Part 17 entire rule eff. 08/14/2014.

Part 17 entire rule eff. 11/14/2017.

Part 17 rules 17.1.4.1(2)(b), 17.1.5, 17.2.2, 17.3, 17.4.1, 17.4.3, 17.7-17.11, 17.14, 17.15.7-17.15.15, 17.17.1.4, 17.17.1.10, 17A2.1(2) eff. 10/15/2020.

Part 17 rules 17.1.4.1(7)- 17.1.5.2, 17.2.2, 17.10.2, 17.11-17.11.4.4, 17.17.3.1(1), Appendix 17A 17A2.2, Table 17A1 eff. 12/15/2022.