

PART XV

TRANSPORTATION OF RADIOACTIVE MATERIALS

R8 64E-5.1501 Purpose and Scope.

(1) The packaging and transportation of radioactive material are also subject to the requirements of other agencies such as the U.S. Department of Transportation, the U.S. Nuclear Regulatory Commission and the U.S. Postal Service. The requirements of this part are in addition to, and not in substitution for, other requirements.

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Determinations and listings of A_1 and A_2 values are found in 10 CFR Part 71, Appendix A as published 01/01/2012 which is herein incorporated by reference and can be obtained from the internet at <http://www.flrules.org/Gateway/reference.asp?No=Ref-03457> or at <http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol2/pdf/CFR-2012-title10-vol2-part71.pdf>.

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

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Definition of terms used in this part are those listed in 49 C.F.R. and 10 C.F.R. 71.4, except that whenever a definition refers to evaluation or approval by the U.S. Department of Transportation or NRC, and such evaluation or approval is within the jurisdiction of the State of Florida as an Agreement State, the Department shall perform the evaluation or approval.

Specific Authority: 404.051, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.20(1), F.S.

R12 History: New July 17, 1985, Amended May 15, 1996, Formerly 10D-91.2001, Amended 2-28-08, 12-26-13.

64E-5.1502 Transportation of Radioactive Material.

(1) No person shall deliver radioactive material to a carrier for transport or transport radioactive material except as authorized in a general license or specific license issued by the department or as exempted in 64E-5.1503.

(2) Each licensee who transports radioactive material outside of the confines of his facility or other place of use, or who offers radioactive material to a carrier for transport shall:

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(a) Comply with the current applicable requirements, appropriate to the mode of transport, of 49 CFR Parts 107, 171-180, 383, 390-397 published on 01/01/2012 which is herein incorporated by reference and can be obtained from the internet <http://www.flrules.org/Gateway/reference.asp?No=Ref-03458>, <https://www.flrules.org/Gateway/reference.asp?No=Ref-03473>, <https://www.flrules.org/Gateway/reference.asp?No=Ref-03474>,

R12 <https://www.flrules.org/Gateway/reference.asp?No=Ref-03475>, and
R12 <https://www.flrules.org/Gateway/reference.asp?No=Ref-03476> or at
R12 <http://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR&searchPath=Title+49%2FSubtitle+B&oldPath=Title+49&isCollapsed=true&selectedYearFrom=2012&ycord=1546> and 10 C.F.R. Part 71
R12 published on 01/01/2012 which is herein incorporated by reference and
R12 can be obtained from the internet at
R12 <http://www.flrules.org/Gateway/reference.asp?No=Ref-03459> or at
R12 <http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol2/pdf/CFR-2012-title10-vol2-part71.pdf>, and 10 C.F.R. Parts 73.72 through 73.74 published on
R12 01/01/2012 which is herein incorporated by reference and can be obtained
R12 from the internet at <http://www.flrules.org/Gateway/reference.asp?No=Ref-03460> or at
R12 <http://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR&searchPath=Title+10%2FChapter+1%2FPart+73%2FSubjgrp&oldPath=Title+10%2FChapter+1%2FPart+73%2FSubjgrp&isCollapsed=true&selectedYearFrom=2012&ycord=1772>.

- (b) Establish procedures for safely opening and closing packages in which radioactive material is transported and to assure that, prior to the delivery to a carrier for transport, each package is properly closed for transport; and
- (c) Assure that any special instructions needed to safely open the package are sent to or have been made available to the consignee.

R8 (d) The licensee shall comply with U.S. Department of Transportation and
R8 NRC regulations in the following areas:

- R8 1. Packaging, 49 C.F.R. part 173, subparts A, B, and I;
- R8 2. Marking and labeling, 49 C.F.R. part 172, subpart D, §§172.400
R8 through 172.407, §§172.436 through 172.441 of subpart E;
- R8 3. Placarding, 49 C.F.R. part 172, subpart F, especially §§172.500
R8 through 172.519 and 172.556, and appendices B and C;
- R8 4. Accident reporting, 49 C.F.R. part 171, §§171.15 and 171.16;
- R8 5. Shipping papers and emergency information,
R8 49 C.F.R. part 172, subparts C and G;
- R8 6. Hazardous material employee training,
R8 49 C.F.R. part 172, subpart H;
- R8 7. Security plans, 49 C.F.R. part 172, subpart I;
- R8 8. Hazardous material shipper/carrier registration,
R8 49 C.F.R. part 107, subpart G;
- R8 9. Definitions, 10 C.F.R. 71.4;
- R8 10. Transportation of licensed material, 10 C.F.R. 71.5;

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- R8 11. Exemptions for low level material, 10 C.F.R. 71.14(a);
- R8 12. General license, NRC-approved package, 10 C.F.R. 71.17;
- R8 13. Previously approved package, 10 C.F.R. 71.19(a) and (b);
- R8 14. General license, U.S. Department of Transportation specification
R8 container material, 10 C.F.R. 71.20;
- R8 15. General license, Use of foreign approved package,
R8 10 C.F.R. 71.21;
- R8 16. General license, Fissile material, 10 C.F.R. 71.22;
- R8 17. External radiation standards for all packages, 10 C.F.R. 71.47;
- R8 18. Assumptions as to unknown properties, 10 C.F.R. 71.83;
- R8 19. Preliminary determinations, 10 C.F.R. 71.85;
- R8 20. Routine determinations, 10 C.F.R. 71.87;
- R8 21. Air transportation of plutonium, 10 C.F.R. 71.88;
- R8 22. Opening instructions, 10 C.F.R. 71.89;
- R8 23. Advance notification of shipment of irradiated reactor fuel and
R8 nuclear waste, 10 C.F.R. 71.97
- R8 24. Quality assurance requirements,
R8 10 C.F.R. 71.101(a), (b), (c), (f) and (g);
- R8 25. Quality assurance organization, 10 C.F.R. 71.103;
- R8 26. Quality assurance program, 10 C.F.R. 71.105;
- R8 27. Exemption of physicians, 10 C.F.R. 71.13;
- R8 28. Handling storage and shipping control, 10 C.F.R. 71.127;
- R8 29. Inspection tests and operating status, 10 C.F.R. 71.129;
- R8 30. Nonconforming materials parts or components, 10 C.F.R. 71.131;
- R8 31. Corrective action, 10 C.F.R. 71.13;
- R8 32. Quality assurances records, 10 C.F.R. 71.135;
- R8 33. Audits, 10 C.F.R. 71.137;
- R8 34. Appendix A to Part 71; and
- R8 35. General license plutonium beryllium special form material.

R8 (e) The licensee shall also comply with U.S. Department of Transportation
R8 regulations pertaining to the following modes of transportation:

R8 1. Rail, 49 C.F.R. part 174, subparts A through D and K;

R8 2. Air, 49 C.F.R. part 175;

R8 3. Vessel, 49 C.F.R. part 176, subparts A through F and M; and

R8 4. Public Highway, 49 C.F.R. part 177 and parts 390 through 397.

R8 (3) If U.S. Department of Transportation regulations are not applicable to a shipment
R8 of licensed material, the licensee shall conform to the standards and
R8 requirements of the U.S. Department of Transportation specified in paragraph (2)
R8 of this section to the same extent as if the shipment or transportation were
R8 subject to U.S. Department of Transportation regulations. A request for
R8 modification, waiver, or exemption from those requirements, and any notification
R8 referred to in those requirements, must be filed with, or made to, the Department.

Specific Authority: 404.051, 404.061, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.141, 404.20(1), F.S.

R12 History: New July 17, 1985, Formerly 10D-91.2003, Amended 10-8-00, 9-28-06, 2-28-08, 12-26-13.

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64E-5.1503 Exemptions.

- (1) Common and contract carriers, freight forwarders, and warehousemen who are subject to the requirements of the U.S. Department of Transportation in 49 CFR Parts 170 through 189 or the U.S. Postal Service in the Postal Service Manual (Domestic Mail Manual), Section 124.3 incorporated by reference, 39 CFR Part 111.1 (1974), are exempt from these regulations to the extent that they transport or store radioactive material in the regular course of their carriage for another or storage incident thereto. Common and contract carriers who are not subject to the requirements of the U.S. Department of Transportation or U.S. Postal Service are subject to 64E-5.1501 and other applicable sections of these regulations.
- (2) Any licensee is exempt from the requirements of this part to the extent that he delivers to a carrier for transport a package containing radioactive material having a specific activity not greater than 0.002 microcurie (74 Bq) per gram.

Specific Authority: 404.051, 404.061, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2004.

64E-5.1504 General Licenses for Carriers.

- (1) A general license is hereby issued to any common or contract carrier not exempt under 64E-5.1503 to receive, possess, transport and store radioactive material in the regular course of their carriage for another or storage incident thereto, provided the transportation and storage is in accordance with the applicable requirements, appropriate to the mode of transport, of the U.S. Department of Transportation insofar as such requirements relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting. Any notification of incidents referred to in these U.S. Department of Transportation requirements shall also be filed with, or made to, the department.
- (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 U.S. Department of Transportation insofar as such requirements relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting. Any notification of incidents referred to in these U.S. Department of Transportation requirements shall be filed with, or made to, the department.
- (3) Persons who transport radioactive material pursuant to the general license in 64E-5.1504(1) or (2) are exempt from the requirements of Parts III and IX to the extent that they transport radioactive material.

Specific Authority: 404.051, 404.061, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2005.

64E-5.1505 Routine Determinations. Prior to each shipment of radioactive material, the licensee shall ensure that the package with its contents satisfies the applicable requirements of this part and of the license. The licensee shall determine that:

- (1) The package is proper for the contents to be shipped;
- (2) The package is in an unimpaired physical condition except for superficial defects such as marks or dents;
- (3) Each closure device of the packaging, including any required gasket, is properly installed and secured and free of defects;
- (4) Any system for containing liquid is adequately sealed and has adequate space or other specified provision for expansion of the liquid;
- (5) Any pressure relief device is operable and set in accordance with written procedures;
- (6) The package has been loaded and closed in accordance with written procedures;
- (7) Any structural part of the package which could be used to lift or tie down the package during transport is rendered inoperable for that purpose unless it satisfies design requirements specified by the U.S. Nuclear Regulatory Commission;
- (8) The level of nonfixed or removable radioactive contamination on the external surfaces of each package presented for shipment is as low as reasonably achievable and shall not exceed the applicable levels specified in the regulations of the U.S. Department of Transportation, 49 CFR 173.443; and
- (9) The external radiation levels around the package and around the vehicle, if applicable, will not exceed the limits specified in the regulations of the U.S. Department of Transportation, 49 CFR 173.441.

Specific Authority: 404.051, 404.061, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2006.

64E-5.1506 Advance Notification of Shipment of Certain Quantities of Radioactive Waste.

- (1) In addition to the notification requirements of 64E-5.1508, prior to the transport of certain quantities of radioactive waste outside of the confines of the licensee's facility or other place of use or storage, or prior to the delivery of certain quantities of radioactive waste to a carrier for transport, each licensee shall provide advance notification of such transport in writing to the governor, or governor's designee, of each state through which the waste will be transported. A list of the mailing addresses of the governors and governors' designees is available upon request from the Director, Office of State Programs, U.S. Nuclear Regulatory Commission, Washington, D.C., 20555.

- (2) Such advance notification is required only when:
- (a) The radioactive waste is required to be in Type B packaging for transportation;
 - (b) The radioactive waste is being transported to, through, or across state boundaries to a disposal site or to a collection point for transport to a disposal site;
 - (c) The quantity of licensed material in a single package exceeds:
 - 1. Five thousand curies (185 TBq) of special form radionuclides; or
 - 2. Five thousand curies (185 TBq) of uncompressed gases of argon 41, krypton 85m, krypton 87, xenon 131m, or xenon 135; or
 - 3. Fifty thousand curies (1.85 PBq) of argon 37, or of uncompressed gases of krypton 85 or xenon 133, or of hydrogen 3 as a gas, as luminous paint, or adsorbed on solid material; or
 - 4. Twenty curies (740 GBq) of other nonspecial form radionuclides for which A_2 is less than or equal to 4 curies (148 GBq); or
 - 5. Two hundred curies (7.4 TBq) of other nonspecial form radionuclides for which A_2 is greater than 4 curies (148 GBq); and
 - (d) The quantity of spent nuclear fuel is less than that subject to advance notification requirements of 10 CFR Part 73.
- (3) Each advance notification required by (1) shall contain the following information:
- (a) The name, address, and telephone number of the generator, carrier and receiver of the radioactive waste shipment;
 - (b) A description of the radioactive waste contained in the shipment as required by the regulations of the U.S. Department of Transportation;
 - (c) The point of origin of the shipment and the 7-day period during which departure of the shipment is estimated to occur;
 - (d) The 7-day period during which arrival of the shipment at state boundaries is estimated to occur;
 - (e) The destination of the shipment, and the 7-day period during which arrival of the shipment is estimated to occur; and
 - (f) A point of contact with a telephone number for current shipment information.

- (4) The notification required by 64E-5.1506(1) shall be made in writing to the office of each appropriate governor or governor's designee and to the department. 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. A notification delivered by messenger must reach the office of the governor, or governor's designee, at least 4 days before the beginning of the 7-day period during which departure of the shipment is estimated to occur. A copy of the notification shall be retained by the licensee for 1 year for inspection by the department.
- (5) The licensee shall notify each appropriate governor, or governor's designee, and the department of any changes to schedule information provided pursuant to 64E-5.1506(1). Such notification shall be by telephone to a responsible individual in the office of the governor, or governor's designee, of the appropriate states. The licensee shall maintain for 1 year for inspection by the department a record of the name of the individual contacted.
- (6) Each licensee who cancels a radioactive waste shipment, for which advance notification has been sent, shall send a cancellation notice to the governor, or governor's designee, of each appropriate state and to the department. A copy of the notice shall be retained by the licensee for 1 year for inspection by the department.

Specific Authority: 404.051, 404.061, 404.081, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.081(1), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2007.

64E-5.1507 Designation of Routes for Shipment of Radioactive Waste Requiring Advanced Notification.

- (1) The department may designate routes within the state of Florida for all shipments requiring advanced notification under 64E-5.1506. Factors that the department will consider in the designation of routes for shipments requiring advanced notifications are:
 - (a) Population density in the vicinity of available highways;
 - (b) Accident rates of available highways;
 - (c) Transit time;
 - (d) Time and day of the week during which the shipment is to occur; and
 - (e) Routes that may have been previously designated by other states.
- (2) In lieu of the department's designation of routes, the interstate highway system and limited access roadways are preferred for transportation of radioactive waste requiring advanced notification pursuant to 64E-5.1506.

Specific Authority: 404.051, 404.061, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6), 404.061(2), 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2008.

64E-5.1508 Inspection of Low-Level Radioactive Waste Shipments.

- (1) All persons licensed by the department to use, manufacture, produce, transfer, transport, receive, acquire, own, process or possess radioactive materials, as well as nuclear power plants licensed by the U.S. Nuclear Regulatory Commission, and who desire to ship radioactive waste, including radioactive waste requiring advance notification as specified in 64E-5.1506, to a low-level radioactive waste treatment, storage or disposal facility, shall notify the department no less than 48 hours prior to departure of the shipment. The notification shall be made in writing or by telephone.
 - (a) Each notification must contain the following information:
 1. The name, address and telephone number of the generator;
 2. The name and telephone number of the contact person, designated by the generator, with whom the department may make arrangements for the inspection;
 3. The name and telephone number of the carrier;
 4. The location of departure, if different from the address of the generator;
 5. The scheduled date and time of departure; and
 6. The proposed route to the low-level radioactive waste facility.
- (2) Upon notification from a licensee or nuclear power plant licensed by the U.S. Nuclear Regulatory Commission, the department shall dispatch an authorized representative to the licensee's facility to inspect the shipment of radioactive waste destined for a low-level radioactive waste treatment, storage or disposal facility. The inspection shall include:
 - (a) Surveys of the external radiation levels of the vehicle;
 - (b) Inspection of package integrity, bracing and blocking, if accessible;
 - (c) Verification of required package marking and labeling, if accessible;
 - (d) Verification of required vehicle placarding; and
 - (e) Examination of the shipping papers for compliance with the regulations of the U.S. Department of Transportation.
- (3) Licensees or nuclear power plants licensed by the U.S. Nuclear Regulatory Commission shall also provide the department's representative the following information or material during the course of inspection of the low-level radioactive waste shipment:
 - (a) Time of departure of shipment;

- (b) Proposed route of the shipment to the low-level radioactive waste facility;
 - (c) Estimated time of arrival of the shipment at the low-level radioactive waste facility;
 - (d) The carrier's name;
 - (e) A complete and legible copy of the bill of lading; and
 - (f) A complete and legible copy of the radioactive shipment manifest.
- (4) If the shipment of low-level radioactive waste is found to be in compliance with the regulations of the U.S. Department of Transportation, the department's representative shall affix his initials on the bill of lading and the shipment may then proceed to the low-level radioactive waste facility. If the shipment of low-level radioactive waste is found to be in violation of the regulations of the U.S. Department of Transportation by the department's representative, the licensee shall not allow the shipment to leave the boundaries of his facility until the violation is corrected and the department's representative affixes his initials on the bill of landing signifying the shipment is in compliance.
- (5) Licensees or nuclear power plant licensees of the U.S. Nuclear Regulatory Commission shall, within 72 hours of receiving notice of arrival of their shipment at its destination for unloading, notify the department of such arrival. The licensee shall also forward to the department within 2 weeks of receiving notice of the arrival of the shipment at a destination for unloading, records of receipt and any other records indicating that a shipment was found in violation of the low-level radioactive waste treatment, storage or disposal facility's or host state's rules or regulations.
- (6) Each generator of radioactive waste whose shipment is inspected by the department's representative will be billed quarterly by the department a fee of \$1.95 per cubic foot (0.02832 cubic meter) of waste shipped or \$150.00 per shipment inspected, whichever is greater. This quarterly billing will be paid to the department within 30 days of receipt of the bill.

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Specific Authority: 404.051, 404.061, 404.071, 404.20, F.S.

R7 Law Implemented: 404.022, 404.051, 404.061, 404.071, 404.20, F.S.

R7 History: New July 17, 1985, Amended July 5, 1988, Formerly 10D-91.2009, Amended August 16, 2007.

64E-5.1509 Permit Requirements.

- (1) Any carrier who transports low-level radioactive waste destined for a low-level radioactive waste treatment, storage or disposal facility, prior to entrance into the state of Florida, shall obtain a permit from the department for transporting such waste into the state.
- (a) An application for a permit must contain the following information or material:

1. Name, address and telephone number of the carrier; and
 2. Certification statement that the carrier will comply with this part and the regulations of the U.S. Department of Transportation.
- (b) Each application for a permit must be accompanied by an annual fee of \$100. Permits shall be valid for 365 days following the date of issue. Permit fees are not refundable. Permits may not be transferred or assigned to another carrier.
- (2) (a) Before any shipment of low-level radioactive waste may be transported into or through the state, the permitted carrier shall give written or telephonic notice to the department not less than 48 hours prior to the date of the arrival of the shipment at the borders of the state. The carrier must provide the department with the following information in the notice:
1. The expected date and time the shipment will arrive at the borders of the state;
 2. The estimated time the shipment will remain in the state;
 3. An estimate of the radioisotopes contained within the shipment;
 4. An estimate of the total activity, in curies, contained within the shipment;
 5. An estimate of the total volume, in cubic feet, contained within the shipment; and
 6. The proposed route over which the shipment will be transported.
- (b) The carrier must immediately notify the department of any cancellations or changes of information provided in the prior notification, such as changes in the date of shipment arrival, the length of time the shipment will remain in the state, or the description or quantity of the radioactive waste contained within the shipment.
- (3) Any permit issued pursuant to 64E-5.1509(1), may be suspended if the department has reasonable cause to suspect that the continued shipment of low-level radioactive waste presents a hazard to the public health. Grounds for suspension of a permit may include failure to include the information requested pursuant to 64E-5.1509(2), falsification of information submitted on the application for a permit, or violation of Florida law or department regulations. Prior to the suspension of a permit, the holder of the permit shall be notified in writing that the permit will be suspended and that an opportunity for an administrative hearing will be provided, if requested in writing within 30 days of the receipt of the notice of the intent to suspend the permit. The department may remove the suspension at any time if the department determines that the suspected hazard no longer exists.

- (4) All applications for permits and prior notifications of impending shipments shall be addressed to the department as outlined in 64E-5.1513(2).

Specific Authority: 404.051, 404.061, 404.131, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.131(2)(3), 404.20(6)(7)(8), F.S.

History: New July 17, 1985, Formerly 10D-91.2010.

64E-5.1510 Air Transport of Plutonium. Notwithstanding the provisions of any general license and notwithstanding any exemptions stated directly in this part or included indirectly by citation of the U.S. Department of Transportation regulations, as may be applicable, the licensee shall assure that plutonium in any form is not transported by air or offered to a carrier for air transport unless:

- (1) The plutonium is contained in a medical device designed for individual human application; or
- (2) The plutonium is contained in a material in which the specific activity is not greater than 0.002 microcuries (74 Bq) per gram of material and in which the radioactivity is essentially uniformly distributed; or
- (3) The plutonium is shipped in a single package containing no more than an A_2 quantity of plutonium in any isotope or form and is shipped in accordance with 64E-5.1502; or
- (4) The plutonium is shipped in a package specifically authorized for the shipment of plutonium by air in the Certificate of Compliance for that package issued by the U.S. Nuclear Regulatory Commission.

Specific Authority: 404.051, 404.061, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2011.

64E-5.1511 Notification in the Event of Suspected or Real Breach of Containment. In addition to the reporting requirements of the U.S. Department of Transportation, any carrier transporting radioactive material in the state shall notify the department immediately in the event the carrier suspects or knows of a breach in the containment of the radioactive material being transported. Notification shall be made as described in 64E-5.1513(2).

Specific Authority: 404.051, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2012.

64E-5.1512 Inspections.

- (1) A department representative is authorized to inspect any record of persons engaged in the transportation of a radioactive material where such records reasonably relate to packaging, preparing for shipment and transporting radioactive material.
- (2) A department representative is authorized to enter upon and inspect the premises and transport vehicles of any person engaged in the transportation of radioactive material for the purpose of determining compliance with or violation of the provisions of section 404.20, Florida Statutes, and these regulations.
- (3) The department may investigate the cause and circumstances of every event in which notification was made pursuant to 64E-5.1511.

Specific Authority: 404.051, 404.061, 404.071, F.S.

Law Implemented: 404.022, 404.051(1)(4)(12), 404.061(2), 404.071(1), 404.20(1)(2)(7)(8), F.S.

History: New July 17, 1985, Formerly 10D-91.2013.

64E-5.1513 Communications.

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- (1) All communications concerning this part should be addressed to:
Department of Health, Bureau of Radiation Control, Bin #C21,
4052 Bald Cypress Way, Tallahassee, FL 32399-1741.
- (2) All notifications required to be made pursuant to 64E-5.1506, 64E-5.1508, 64E-5.1509 and 64E-5.1511 shall be addressed to:
Department of Health, Bureau of Radiation Control, Post Office Box 680069,
Orlando, Florida 32868-0069; telephone (407) 297-2095.
- (3) Immediate notification as required by 64E-5.1511 shall be made by telephone or telegraph.

Specific Authority: 404.042, 404.051, 404.20, F.S.

Law Implemented: 404.042, 404.051(1)(4)(6)(11), 404.061(2), 404.081(1), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Amended April 4, 1989, Formerly 10D-91.2014.

Appendix A to Part 71 - Determination of A₁ and A₂

- I. Values of A₁ and A₂ for individual radionuclides, which are the bases for many activity limits elsewhere in these regulations are given in Table A-1. The curie (Ci) values specified are obtained by converting from the Terabecquerel (TBq) figure. The curie values are expressed to three significant figures to assure that the difference in the TBq and Ci quantities is one tenth of one percent or less. 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.
- II. For individual radionuclides whose identities are known, but which are not listed in Table A-1, the determination of the values of A₁ and A₂ requires Commission approval, except that the values of A₁ and A₂ in Table A-2 may be used without obtaining Commission approval.
- III. In the calculations of A₁ and A₂ for a radionuclide not in Table A-1, a single radioactive decay chain, in which radionuclides are present in their naturally occurring proportions, and in which no daughter 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 daughter nuclide has a half-life either longer than 10 days, or greater than that of the parent nuclide, the parent and those daughter nuclides shall be considered as mixtures of different nuclides.
- IV. For mixtures of radionuclides whose identities and respective activities are known, the following conditions apply:
- (a) For special form radioactive material, the maximum quantity transported in a Type A package:
- $$\sum_i \frac{B(i)}{A_1(i)} \text{ less than or equal to } 1$$
- (b) For normal form radioactive material, the maximum quantity transported in a Type A package:
- $$\sum_i \frac{B(i)}{A_2(i)} \text{ less than or equal to } 1$$
- where B(i) is the activity of radionuclide i and A₁(i) and A₂(i) are the A₁ and A₂ values for radionuclide i, respectively.

Alternatively, an A_1 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 $A_1(i)$ is the appropriate A_1 value for nuclide i .

An A_2 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 $A_2(i)$ is the appropriate A_2 value for nuclide i .

- V. 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 paragraph IV. 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.

Table A-1 A₁ and A₂ Values for Radionuclide

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Ac-225	Actinium(89)	0.6	16.2	1x10 ⁻²	0.270	2.1x10 ³	5.8x10 ⁴
Ac-227		40	1080	2x10 ⁻⁵	5.41x10 ⁻⁴	2.7	7.2x10 ¹
Ac-228		0.6	16.2	0.4	10.8	8.4x10 ⁴	2.2x10 ⁶
Ag-105	Silver(47)	2	54.1	2	54.1	1.1x10 ³	3.0x10 ⁴
Ag-108m		0.6	16.2	0.6	16.2	9.7x10 ⁻¹	2.6x10 ¹
Ag-110m		0.4	10.8	0.4	10.8	1.8x10 ²	4.7x10 ³
Ag-111		0.6	16.2	0.5	13.5	5.8x10 ³	1.6x10 ⁵
Al-26	Aluminum(13)	0.4	10.8	0.4	10.8	7.0x10 ⁻⁴	1.9x10 ⁻²
Am-241	Americium(95)	2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	1.3x10 ⁻¹	3.4
Am-242m		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	3.6x10 ⁻¹	1.0x10 ¹
Am-243		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	7.4x10 ⁻³	2.0x10 ⁻¹
Ar-37	Argon(18)	40	1080	40	1080	3.7x10 ³	9.9x10 ⁴
Ar-39		20	541	20	541	1.3x10 ⁰	3.4x10 ¹
Ar-41		0.6	16.2	0.6	16.2	1.5x10 ⁶	4.2x10 ⁷
Ar-42		0.2	5.41	0.2	5.41	9.6	2.6x10 ²
As-72	Arsenic(33)	0.2	5.41	0.2	5.41	6.2x10 ⁴	1.7x10 ⁶
As-73		40	1080	40	1080	8.2x10 ²	2.2x10 ⁴
As-74		1	27.0	0.5	13.5	3.7x10 ³	9.9x10 ⁴
As-76		0.2	5.41	0.2	5.41	5.8x10 ⁴	1.6x10 ⁶
As-77		20	541	0.5	13.5	3.9x10 ⁴	1.0x10 ⁶
At-211	Astatine(85)	30	811	2	54.1	7.6x10 ⁴	2.1x10 ⁶
Au-193	Gold(79)	6	162	6	162	3.4x10 ⁴	9.2x10 ⁵

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Au-194		1	27.0	1	27.0	1.5x10 ⁴	4.1x10 ⁵
Au-195		10	270	10	270	1.4x10 ²	3.7x10 ³
Au-196		2	54.1	2	54.1	4.0x10 ³	1.1x10 ⁵
Au-198		3	81.1	0.5	13.5	9.0x10 ³	2.4x10 ⁵
Au-199		10	270	0.9	24.3	7.7x10 ³	2.1x10 ⁵
Ba-131	Barium(56)	2	54.1	2	54.1	3.1x10 ³	8.4x10 ⁴
Ba-133m		10	270	0.9	24.3	2.2x10 ⁴	6.1x10 ⁵
Ba-133		3	81.1	3	81.1	9.4	2.6x10 ²
Ba-140		0.4	10.8	0.4	10.8	2.7x10 ³	7.3x10 ⁴
Be-7	Beryllium(4)	20	541	20	541	1.3x10 ⁴	3.5x10 ⁵
Be-10		20	541	0.5	13.5	8.3x10 ⁻⁴	2.2x10 ⁻²
Bi-205	Bismuth(83)	0.6	16.2	0.6	16.2	1.5x10 ³	4.2x10 ⁴
Bi-206		0.3	8.11	0.3	8.11	3.8x10 ³	1.0x10 ⁵
Bi-207		0.7	18.9	0.7	18.9	1.9	5.2x10 ¹
Bi-210m		0.3	8.11	3x10 ⁻²	0.811	2.1x10 ⁻⁵	5.7x10 ⁻⁴
Bi-210		0.6	16.2	0.5	13.5	4.6x10 ³	1.2x10 ⁵
Bi-212		0.3	8.11	0.3	8.11	5.4x10 ⁵	1.5x10 ⁷
Bk-247	Berkelium(97)	2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	3.8x10 ⁻²	1.0
Bk-249		40	1080	8x10 ⁻²	2.16	6.1x10 ¹	1.6x10 ³
Br-76	Bromine(35)	0.3	8.11	0.3	8.11	9.4x10 ⁴	2.5x10 ⁶
Br-77		3	81.1	3	81.1	2.6x10 ⁴	7.1x10 ⁵
Br-82		0.4	10.8	0.4	10.8	4.0x10 ⁴	1.1x10 ⁶
C-11	Carbon(6)	1	27.0	0.5	13.5	3.1x10 ⁷	8.4x10 ⁸
C-14		40	1080	2	54.1	1.6x10 ⁻¹	4.5

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Ca-41	Calcium(20)	40	1080	40	1080	3.1x10 ⁻³	8.5x10 ⁻²
Ca-45		40	1080	0.9	24.3	6.6x10 ²	1.8x10 ⁴
Ca-47		0.9	24.3	0.5	13.5	2.3x10 ⁴	6.1x10 ⁵
Cd-109	Cadmium(48)	40	1080	1	27.0	9.6x10 ¹	2.6x10 ³
Cd-113m		20	541	9x10 ⁻²	2.43	8.3x10 ⁰	2.2x10 ²
Cd-115m		0.3	8.11	0.3	8.11	9.4x10 ²	2.5x10 ⁴
Cd-115		4	108	0.5	13.5	1.9x10 ⁴	5.1x10 ⁵
Ce-139	Cerium(58)	6	162	6	162	2.5x10 ²	6.8x10 ³
Ce-141		10	270	0.5	13.5	1.1x10 ³	2.8x10 ⁴
Ce-143		0.6	16.2	0.5	13.5	2.5x10 ⁴	6.6x10 ⁵
Ce-144		0.2	5.41	0.2	5.41	1.2x10 ²	3.2x10 ³
Cf-248	Californium(98)	30	811	3x10 ⁻³	8.11x10 ⁻²	5.8x10 ¹	1.6x10 ³
Cf-249		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	1.5x10 ⁻¹	4.1
Cf-250		5	135	5x10 ⁻⁴	1.35x10 ⁻²	4.0	1.1x10 ²
Cf-251		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	5.9x10 ⁻²	1.6
Cf-252		0.1	2.70	1x10 ⁻³	2.70x10 ⁻²	2.0x10 ¹	5.4x10 ²
Cf-253		40	1080	6x10 ⁻²	1.62	1.1x10 ³	2.9x10 ⁴
Cf-254		3x10 ⁻³	8.11x10 ⁻²	6x10 ⁻⁴	1.62x10 ⁻²	3.1x10 ²	8.5x10 ³
Cl-36	Chlorine(17)	20	541	0.5	13.5	1.2x10 ⁻³	3.3x10 ⁻²
Cl-38		0.2	5.41	0.2	5.41	4.9x10 ⁶	1.3x10 ⁸
Cm-240	Curium(96)	40	1080	2x10 ⁻²	0.541	7.5x10 ²	2.0x10 ⁴
Cm-241		2	54.1	0.9	24.3	6.1x10 ²	1.7x10 ⁴
Cm-242		40	1080	1x10 ⁻²	0.270	1.2x10 ²	3.3x10 ³
Cm-243		3	81.1	3x10 ⁻⁴	8.11x10 ⁻³	1.9	5.2x10 ¹

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Cm-244		4	108.0	4x10 ⁻⁴	1.08x10 ⁻²	3.0	5.7x10 ¹
Cm-245		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	6.4x10 ⁻³	1.7x10 ⁻¹
Cm-246		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	1.1x10 ⁻²	3.1x10 ⁻¹
Cm-247		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	3.4x10 ⁻⁶	9.3x10 ⁻⁵
Cm-248		4x10 ⁻²	1.08	5x10 ⁻⁵	1.35x10 ⁻³	1.6x10 ⁻⁴	4.2x10 ⁻³
Co-55	Cobalt(27)	0.5	13.5	0.5	13.5	1.1x10 ⁵	3.1x10 ⁶
Co-56		0.3	8.11	0.3	8.11	1.1x10 ³	3.0x10 ⁴
Co-57		8	216	8	216	3.1x10 ²	8.4x10 ³
Co-58m		40	1080	40	1080	2.2x10 ⁵	5.9x10 ⁶
Co-58		1	27.0	1	27.0	1.2x10 ³	3.2x10 ⁴
Co-60		0.4	10.8	0.4	10.8	4.2x10 ¹	1.1x10 ³
Cr-51	Chromium(24)	30	811	30	811	3.4x10 ³	9.2x10 ⁴
Cs-129	Cesium(55)	4	108	4	108	2.8x10 ⁴	7.6x10 ⁵
Cs-131		40	1080	40	1080	3.8x10 ³	1.0x10 ⁵
Cs-132		1	27.0	1	27.0	5.7x10 ³	1.5x10 ⁵
Cs-134m		40	1080	9	243	3.0x10 ⁵	8.0x10 ⁶
Cs-134		0.6	16.2	0.5	13.5	4.8x10 ¹	1.3x10 ³
Cs-135		40	1080	0.9	24.3	4.3x10 ⁻⁵	1.2x10 ⁻³
Cs-136		0.5	13.5	0.5	13.5	2.7x10 ³	7.3x10 ⁴
Cs-137		2	54.1	0.5	13.5	3.2	8.7x10 ¹
Cu-64	Copper(29)	5	135	0.9	24.3	1.4x10 ⁵	3.9x10 ⁶
Cu-67		9	243	0.9	24.3	2.8x10 ⁴	7.6x10 ⁵
Dy-159	Dysprosium(66)	20	541	20	541	2.1x10 ²	5.7x10 ³
Dy-165		0.6	16.2	0.5	13.5	3.0x10 ⁵	8.2x10 ⁶

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Dy-166		0.3	8.11	0.3	8.11	8.6x10 ³	2.3x10 ⁵
Er-169	Erbium(68)	40	1080	0.9	24.3	3.1x10 ³	8.3x10 ⁴
Er-171		0.6	16.2	0.5	13.5	9.0x10 ⁴	2.4x10 ⁶
Es-253	Einsteinium(99) ^a	200	5400	2x10 ⁻²	5.4x10 ⁻¹	--	--
Es-254		30	811	3x10 ⁻³	8.11x10 ⁻²	--	--
Es-254m		0.6	16.2	0.4	10.8	--	--
Es-255		--	--	--	--	--	--
Eu-147	Europium(63)	2	54.1	2	54.1	1.4x10 ³	3.7x10 ⁴
Eu-148		0.5	13.5	0.5	13.5	6.0x10 ²	1.6x10 ⁴
Eu-149		20	541	20	541	3.5x10 ²	9.4x10 ³
Eu-150		0.7	18.9	0.7	18.9	6.1x10 ⁴	1.6x10 ⁶
Eu-152m		0.6	16.2	0.5	13.5	8.2x10 ⁴	2.2x10 ⁶
Eu-152		0.9	24.3	0.9	24.3	6.5	1.8x10 ²
Eu-154		0.8	21.6	0.5	13.5	9.8	2.6x10 ²
Eu-155		20	541	2	54.1	1.8x10 ¹	4.9x10 ²
Eu-156		0.6	16.2	0.5	13.5	2.0x10 ³	5.5x10 ⁴
F-18	Fluorine(9)	1	27.0	0.5	13.5	3.5x10 ⁶	9.5x10 ⁷
Fe-52	Iron(26)	0.2	5.41	0.2	5.41	2.7x10 ⁵	7.3x10 ⁶
Fe-55		40	1080	40	1080	8.8x10 ¹	2.4x10 ³
Fe-59		0.8	21.6	0.8	21.6	1.8x10 ³	5.0x10 ⁴
Fe-60		40	1080	0.2	5.41	7.4x10 ⁻⁴	2.0x10 ⁻²
Fm-255	Fermium(100) ^b	40	1080	0.8	21.6	--	--
Fm-257		10	270	8x10 ⁻³	2.16x10 ⁻¹	--	--
Ga-67	Gallium(31)	6	162	6	162	2.2x10 ⁴	6.0x10 ⁵

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Ga-68		0.3	8.11	0.3	8.11	1.5x10 ⁶	4.1x10 ⁷
Ga-72		0.4	10.8	0.4	10.8	1.1x10 ⁵	3.1x10 ⁶
Gd-146	Gadolinium(64)	0.4	10.8	0.4	10.8	6.9x10 ²	1.9x10 ⁴
Gd-148		3	81.1	3x10 ⁻⁴	8.11x10 ⁻³	1.2	3.2x10 ¹
Gd-153		10	270	5	135	1.3x10 ²	3.5x10 ³
Gd-159		4	108	0.5	13.5	3.9x10 ⁴	1.1x10 ⁶
Ge-68	Germanium(32)	0.3	8.11	0.3	8.11	2.6x10 ²	7.1x10 ³
Ge-71		40	1080	40	1080	5.8x10 ³	1.6x10 ⁵
Ge-77		0.3	8.11	0.3	8.11	1.3x10 ⁵	3.6x10 ⁶
H-3	Hydrogen(1) See T-Tritium						
Hf-172	Hafnium(72)	0.5	13.5	0.3	8.11	4.1x10 ¹	1.1x10 ³
Hf-175		3	81.1	3	81.1	3.9x10 ²	1.1x10 ⁴
Hf-181		2	54.1	0.9	24.3	6.3x10 ²	1.7x10 ⁴
Hf-182		4	108	3x10 ⁻²	0.811	8.1x10 ⁻⁶	2.2x10 ⁻⁴
Hg-194	Mercury(80)	1	27.0	1	27.0	1.3x10 ⁻¹	3.5
Hg-195m		5	135	5	135	1.5x10 ⁴	4.0x10 ⁵
Hg-197m		10	270	0.9	24.3	2.5x10 ⁴	6.7x10 ⁵
Hg-197		10	270	10	270	9.2x10 ³	2.5x10 ⁵
Hg-203		4	108	0.9	24.3	5.1x10 ²	1.4x10 ⁴
Ho-163	Holmium(67)	40	1080	40	1080	2.7	7.6x10 ¹
Ho-166m		0.6	16.2	0.3	8.11	6.6x10 ⁻²	1.8
Ho-166		0.3	8.11	0.3	8.11	2.6x10 ⁴	7.0x10 ⁵
I-123	Iodine(53)	6	162	6	162	7.1x10 ⁴	1.9x10 ⁶

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
I-124		0.9	24.3	0.9	24.3	9.3x10 ³	2.5x10 ⁵
I-125		20	541	2	54.1	6.4x10 ²	1.7x10 ⁴
I-126		2	54.1	0.9	24.3	2.9x10 ³	8.0x10 ⁴
I-129		Unlimited	Unlimited	Unlimited	Unlimited	6.5x10 ⁻⁶	1.8x10 ⁻⁴
I-131		3	81.1	0.5	13.5	4.6x10 ³	1.2x10 ⁵
I-132		0.4	10.8	0.4	10.8	3.8x10 ⁵	1.0x10 ⁷
I-133		0.6	16.2	0.5	13.5	4.2x10 ⁴	1.1x10 ⁶
I-134		0.3	8.11	0.3	8.11	9.9x10 ⁵	2.7x10 ⁷
I-135		0.6	16.2	0.5	13.5	1.3x10 ⁵	3.5x10 ⁶
In-111	Indium(49)	2	54.1	2	54.1	1.5x10 ⁴	4.2x10 ⁵
In-113m		4	108	4	108	6.2x10 ⁵	1.7x10 ⁷
In-114m		0.3	8.11	0.3	8.11	8.6x10 ²	2.3x10 ⁴
In-115m		6	162	0.9	24.3	2.2x10 ⁵	6.1x10 ⁶
Ir-189	Iridium(77)	10	270	10	270	1.9x10 ³	5.2x10 ⁴
Ir-190		0.7	18.9	0.7	18.9	2.3x10 ³	6.2x10 ⁴
Ir-192		1	27.0	0.5	13.5	3.4x10 ²	9.2x10 ³
Ir-193m		10	270	10	270	2.4x10 ³	6.4x10 ⁴
Ir-194		0.2	5.41	0.2	5.41	3.1x10 ⁴	8.4x10 ⁵
K-40	Potassium(19)	0.6	16.2	0.6	16.2	2.4x10 ⁻⁷	6.4x10 ⁻⁶
K-42		0.2	5.41	0.2	5.41	2.2x10 ⁵	6.0x10 ⁶
K-43		1.0	27.0	0.5	13.5	1.2x10 ⁵	3.3x10 ⁶
Kr-81	Krypton(36)	40	1080	40	1080	7.8x10 ⁻⁴	2.1x10 ⁻²
Kr-85m		6	162	6	162	3.0x10 ⁵	8.2x10 ⁶
Kr-85		20	541	10	270	1.5x10 ¹	3.9x10 ²

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Kr-87		0.2	5.41	0.2	5.41	1.0x10 ⁶	2.8x10 ⁷
La-137	Lanthanum(57)	40	1080	2	54.1	1.6x10 ⁻³	4.4x10 ⁻²
La-140		0.4	10.8	0.4	10.8	2.1x10 ⁴	5.6x10 ⁵
Lu-172	Lutetium(71)	0.5	13.5	0.5	13.5	4.2x10 ³	1.1x10 ⁵
Lu-173		8	216	8	216	5.6x10 ¹	1.5x10 ³
Lu-174m		20	541	8	216	2.0x10 ²	5.3x10 ³
Lu-174		8	216	4	108	2.3x10 ¹	6.2x10 ²
Lu-177		30	811	0.9	24.3	4.1x10 ³	1.1x10 ⁵
MFP	For mixed fission products, use formula for mixtures or Table A-2.						
Mg-28	Magnesium(12)	0.2	5.41	0.2	5.41	2.0x10 ⁵	5.4x10 ⁶
Mn-52	Manganese(25)	0.3	8.11	0.3	8.11	1.6x10 ⁴	4.4x10 ⁵
Mn-53		Unlimited	Unlimited	Unlimited	Unlimited	6.8x10 ⁻⁵	1.8x10 ⁻³
Mn-54		1	27.0	1	27.0	2.9x10 ²	7.7x10 ³
Mn-56		0.2	5.41	0.2	5.41	8.0x10 ⁵	2.2x10 ⁷
Mo-93	Molybdenum(42)	40	1080	7	189	4.1x10 ⁻²	1.1
Mo-99		0.6	16.2	0.5	13.5 ^c	1.8x10 ⁴	4.8x10 ⁵
N-13	Nitrogen(7)	0.6	16.2	0.5	13.5	5.4x10 ⁷	1.5x10 ⁹
Na-22	Sodium(11)	0.5	13.5	0.5	13.5	2.3x10 ²	6.3x10 ³
Na-24		0.2	5.41	0.2	5.41	3.2x10 ⁵	8.7x10 ⁶
Nb-92m	Niobium(41)	0.7	18.9	0.7	18.9	5.2x10 ³	1.4x10 ⁵
Nb-93m		40	1080	6	162	8.8	2.4x10 ²

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Nb-94		0.6	16.2	0.6	16.2	6.9x10 ⁻³	1.9x10 ⁻¹
Nb-95		1	27.0	1	27.0	1.5x10 ³	3.9x10 ⁴
Nb-97		0.6	16.2	0.5	13.5	9.9x10 ⁵	2.7x10 ⁷
Nd-147	Neodymium(60)	4	108	0.5	13.5	3.0x10 ³	8.1x10 ⁴
Nd-149		0.6	16.2	0.5	13.5	4.5x10 ⁵	1.2x10 ⁷
Ni-59	Nickel(28)	40	1080	40	1080	3.0x10 ⁻³	8.0x10 ⁻²
Ni-63		40	1080	30	811	2.1	5.7x10 ¹
Ni-65		0.3	8.11	0.3	8.11	7.1x10 ⁵	1.9x10 ⁷
Np-235	Neptunium(93)	40	1080	40	1080	5.2x10 ¹	1.4x10 ³
Np-236		7	189	1x10 ⁻³	2.70x10 ⁻²	4.7x10 ⁻⁴	1.3x10 ⁻²
Np-237		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	2.6x10 ⁻⁵	7.1x10 ⁻⁴
Np-239		6	162	0.5	13.5	8.6x10 ³	2.3x10 ⁵
Os-185	Osmium(76)	1	27.0	1	27.0	2.8x10 ²	7.5x10 ³
Os-191m		40	1080	40	1080	4.6x10 ⁴	1.3x10 ⁶
Os-191		10	270	0.9	24.3	1.6x10 ³	4.4x10 ⁴
Os-193		0.6	16.2	0.5	13.5	2.0x10 ⁴	5.3x10 ⁵
Os-194		0.2	5.41	0.2	5.41	1.1x10 ¹	3.1x10 ²
P-32	Phosphorus(15)	0.3	8.11	0.3	8.11	1.1x10 ⁴	2.9x10 ⁵
P-33		40	1080	0.9	24.3	5.8x10 ³	1.6x10 ⁵
Pa-230	Protactinium(91)	2	54.1	0.1	2.70	1.2x10 ³	3.3x10 ⁴
Pa-231		0.6	16.2	6x10 ⁻⁵	1.62x10 ⁻³	1.7x10 ⁻³	4.7x10 ⁻²
Pa-233		5	135	0.9	24.3	7.7x10 ²	2.1x10 ⁴
Pb-201	Lead(82)	1	27.0	1	27.0	6.2x10 ⁴	1.7x10 ⁶
Pb-202		40	1080	2	54.1	1.2x10 ⁻⁴	3.4x10 ⁻³

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Pb-203		3	81.1	3	81.1	1.1x10 ⁴	3.0x10 ⁵
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	4.5x10 ⁻⁶	1.2x10 ⁻⁴
Pb-210		0.6	16.2	9x10 ⁻³	0.243	2.8	7.6x10 ¹
Pb-212		0.3	8.11	0.3	8.11	5.1x10 ⁴	1.4x10 ⁶
Pd-103	Palladium(46)	40	1080	40	1080	2.8x10 ³	7.5x10 ⁴
Pd-107		Unlimited	Unlimited	Unlimited	Unlimited	1.9x10 ⁻⁵	5.1x10 ⁻⁴
Pd-109		0.6	16.2	0.5	13.5	7.9x10 ⁴	2.1x10 ⁶
Pm-143	Promethium(61)	3	81.1	3	81.1	1.3x10 ²	3.4x10 ³
Pm-144		0.6	16.2	0.6	16.2	9.2x10 ¹	2.5x10 ³
Pm-145		30	811	7	189	5.2	1.4x10 ²
Pm-147		40	1080	0.9	24.3	3.4x10 ¹	9.3x10 ²
Pm-148m		0.5	13.5	0.5	13.5	7.9x10 ²	2.1x10 ⁴
Pm-149		0.6	16.2	0.5	13.5	1.5x10 ⁴	4.0x10 ⁵
Pm-151		3	81.1	0.5	13.5	2.7x10 ⁴	7.3x10 ⁵
Po-208	Polonium(84)	40	1080	2x10 ⁻²	0.541	2.2x10 ¹	5.9x10 ²
Po-209		40	1080	2x10 ⁻²	0.541	6.2x10 ⁻¹	1.7x10 ¹
Po-210		40	1080	2x10 ⁻²	0.541	1.7x10 ²	4.5x10 ³
Pr-142	Praseodymium(59)	0.2	5.41	0.2	5.41	4.3x10 ⁴	1.2x10 ⁶
Pr-143		4	108	0.5	13.5	2.5x10 ³	6.7x10 ⁴
Pt-188	Platinum(78)	0.6	16.2	0.6	16.2	2.5x10 ³	6.8x10 ⁴
Pt-191		3	81.1	3	81.1	8.7x10 ³	2.4x10 ⁵
Pt-193m		40	1080	9	243	5.8x10 ³	1.6x10 ⁵
Pt-193		40	1080	40	1080	1.4	3.7x10 ¹
Pt-195m		10	270	2	54.1	6.2x10 ³	1.7x10 ⁵

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Pt-197m		10	270	0.9	24.3	3.7x10 ⁵	1.0x10 ⁷
Pt-197		20	541	0.5	13.5	3.2x10 ⁴	8.7x10 ⁵
Pu-236	Plutonium(94)	7	189	7x10 ⁻⁴	1.89x10 ⁻²	2.0x10 ¹	5.3x10 ²
Pu-237		20	541	20	541	4.5x10 ²	1.2x10 ⁴
Pu-238		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	6.3x10 ⁻¹	1.7x10 ¹
Pu-239		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	2.3x10 ⁻³	6.2x10 ⁻²
Pu-240		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	8.4x10 ⁻³	2.3x10 ⁻¹
Pu-241		40	1080	1x10 ⁻²	0.270	3.8	1.0x10 ²
Pu-242		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	1.5x10 ⁻⁴	3.9x10 ⁻³
Pu-244		0.3	8.11	2x10 ⁻⁴	5.41x10 ⁻³	6.7x10 ⁻⁷	1.8x10 ⁻⁵
Ra-223	Radium(88)	0.6	16.2	3x10 ⁻²	0.811	1.9x10 ³	5.1x10 ⁴
Ra-224		0.3	8.11	6x10 ⁻²	1.62	5.9x10 ³	1.6x10 ⁵
Ra-225		0.6	16.2	2x10 ⁻²	0.541	1.5x10 ³	3.9x10 ⁴
Ra-226		0.3	8.11	2x10 ⁻²	0.541	3.7x10 ⁻²	1.0
Ra-228		0.6	16.2	4x10 ⁻²	1.08	1.0x10 ¹	2.7x10 ²
Rb-81	Rubidium(37)	2	54.1	0.9	24.3	3.1x10 ⁵	8.4x10 ⁶
Rb-83		2	54.1	2	54.1	6.8x10 ²	1.8x10 ⁴
Rb-84		1	27.0	0.9	24.3	1.8x10 ³	4.7x10 ⁴
Rb-86		0.3	8.11	0.3	8.11	3.0x10 ³	8.1x10 ⁴
Rb-87		Unlimited	Unlimited	Unlimited	Unlimited	3.2x10 ⁻⁹	8.6x10 ⁻⁸
Rb (natural)		Unlimited	Unlimited	Unlimited	Unlimited	6.7x10 ⁶	1.8x10 ⁸
Re-183	Rhenium(75)	5	135	5	135	3.8x10 ²	1.0x10 ⁴
Re-184m		3	81.1	3	81.1	1.6x10 ²	4.3x10 ³
Re-184		1	27.0	1	27.0	6.9x10 ²	1.9x10 ⁴

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Re-186		4	108	0.5	13.5	6.9x10 ³	1.9x10 ⁵
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	1.4x10 ⁻⁹	3.8x10 ⁻⁸
Re-188		0.2	5.41	0.2	5.41	3.6x10 ⁴	9.8x10 ⁵
Re-189		4	108	0.5	13.5	2.5x10 ⁴	6.8x10 ⁵
Re (natural)		Unlimited	Unlimited	Unlimited	Unlimited	"8.9x10 ⁻¹⁰ "	2.4x10 ⁻⁸
Rh-99	Rhodium(45)	2	54.1	2	54.1	3.0x10 ³	8.2x10 ⁴
Rh-101		4	108	4	108	4.1x10 ¹	1.1x10 ³
Rh-102m		2	54.1	0.9	24.3	2.3x10 ²	6.2x10 ³
Rh-102		0.5	13.5	0.5	13.5	4.5x10 ¹	1.2x10 ³
Rh-103m		40	1080	40	1080	1.2x10 ⁶	3.3x10 ⁷
Rh-105		10	270	0.9	24.3	3.1x10 ⁴	8.4x10 ⁵
Rn-222	Radon(86)	0.2	5.41	4x10 ⁻³	0.108	5.7x10 ³	1.5x10 ⁵
Ru-97	Ruthenium(44)	4	108	4	108	1.7x10 ⁴	4.6x10 ⁵
Ru-103		2	54.1	0.9	24.3	1.2x10 ³	3.2x10 ⁴
Ru-105		0.6	16.2	0.5	13.5	2.5x10 ⁵	6.7x10 ⁶
Ru-106		0.2	5.41	0.2	5.41	1.2x10 ²	3.3x10 ³
S-35	Sulfur(16)	40	1080	2	54.1	1.6x10 ³	4.3x10 ⁴
Sb-122	Antimony(51)	0.3	8.11	0.3	8.11	1.5x10 ⁴	4.0x10 ⁵
Sb-124		0.6	16.2	0.5	13.5	6.5x10 ²	1.7x10 ⁴
Sb-125		2	54.1	0.9	24.3	3.9x10 ¹	1.0x10 ³
Sb-126		0.4	10.8	0.4	10.8	3.1x10 ³	8.4x10 ⁴
Sc-44	Scandium(21)	0.5	13.5	0.5	13.5	6.7x10 ⁵	1.8x10 ⁷
Sc-46		0.5	13.5	0.5	13.5	1.3x10 ³	3.4x10 ⁴
Sc-47		9	243	0.9	24.3	3.1x10 ⁴	8.3x10 ⁵

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Sc-48		0.3	8.11	0.3	8.11	5.5x10 ⁴	1.5x10 ⁶
Se-75	Selenium(34)	3	81.1	3	81.1	5.4x10 ²	1.5x10 ⁴
Se-79		40	1080	2	54.1	2.6x10 ⁻³	7.0x10 ⁻²
Si-31	Silicon(14)	0.6	16.2	0.5	13.5	1.4x10 ⁶	3.9x10 ⁷
Si-32		40	1080	0.2	5.41	3.9	1.1x10 ²
Sm-145	Samarium(62)	20	541	20	541	9.8x10 ¹	2.6x10 ³
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	8.5x10 ⁻¹⁰	2.3x10 ⁻⁸
Sm-151		40	1080	4	108	9.7x10 ⁻¹	2.6x10 ¹
Sm-153		4	108	0.5	13.5	1.6x10 ⁴	4.4x10 ⁵
Sn-113	Tin(50)	4	108	4	108	3.7x10 ²	1.0x10 ⁴
Sn-117m		6	162	2	54.1	3.0x10 ³	8.2x10 ⁴
Sn-119m		40	1080	40	1080	1.4x10 ²	3.7x10 ³
Sn-121m		40	1080	0.9	24.3	2.0	5.4x10 ¹
Sn-123		0.6	16.2	0.5	13.5	3.0x10 ²	8.2x10 ³
Sn-125		0.2	5.41	0.2	5.41	4.0x10 ³	1.1x10 ⁵
Sn-126		0.3	8.11	0.3	8.11	1.0x10 ⁻³	2.8x10 ⁻²
Sr-82	Strontium(38)	0.2	5.41	0.2	5.41	2.3x10 ³	6.2x10 ⁴
Sr-85m		5	135	5	135	1.2x10 ⁶	3.3x10 ⁷
Sr-85		2	54.1	2	54.1	8.8x10 ²	2.4x10 ⁴
Sr-87m		3	81.1	3	81.1	4.8x10 ⁵	1.3x10 ⁷
Sr-89		0.6	16.2	0.5	13.5	1.1x10 ³	2.9x10 ⁴
Sr-90		0.2	5.41	0.1	2.70	5.1	1.4x10 ²
Sr-91		0.3	8.11	0.3	8.11	1.3x10 ⁵	3.6x10 ⁶
Sr-92		0.8	21.6	0.5	13.5	4.7x10 ⁵	1.3x10 ⁷

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
T	Tritium(1)	40	1080	40 ^d	1080 ^d	3.6x10 ²	9.7x10 ³
Ta-178	Tantalum(73)	1	27.0	1	27.0	4.2x10 ⁶	1.1x10 ⁸
Ta-179		30	811	30	811	4.1x10 ¹	1.1x10 ³
Ta-182		0.8	21.6	0.5	13.5	2.3x10 ²	6.2x10 ³
Tb-157	Terbium(65)	40	1080	10	270	5.6x10 ⁻¹	1.5x10 ¹
Tb-158		1	27.0	0.7	18.9	5.6x10 ⁻¹	1.5x10 ¹
Tb-160		0.9	24.3	0.5	13.5	4.2x10 ²	1.1x10 ⁴
Tc-95m	Technetium(43)	2	54.1	2	54.1	8.3x10 ²	2.2x10 ⁴
Tc-96m		0.4	10.8	0.4	10.8	1.4x10 ⁶	3.8x10 ⁷
Tc-96		0.4	10.8	0.4	10.8	1.2x10 ⁴	3.2x10 ⁵
Tc-97m		40	1080	40	1080	5.6x10 ²	1.5x10 ⁴
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	5.2x10 ⁻⁵	1.4x10 ⁻³
Tc-98		0.7	18.9	0.7	18.9	3.2x10 ⁻⁵	8.7x10 ⁻⁴
Tc-99m		8	216	8	216	1.9x10 ⁵	5.3x10 ⁶
Tc-99		40	1080	0.9	24.3	6.3x10 ⁻⁴	1.7x10 ⁻²
Te-118	Tellurium(52)	0.2	5.41	0.2	5.41	6.8x10 ³	1.8x10 ⁵
Te-121m		5	135	5	135	2.6x10 ²	7.0x10 ³
Te-121		2	54.1	2	54.1	2.4x10 ³	6.4x10 ⁴
Te-123m		7	189	7	189	3.3x10 ²	8.9x10 ³
Te-125m		30	811	9	243	6.7x10 ²	1.8x10 ⁴
Te-127m		20	541	0.5	13.5	3.5x10 ²	9.4x10 ³
Te-127		20	541	0.5	13.5	9.8x10 ⁴	2.6x10 ⁶
Te-129m		0.6	16.2	0.5	13.5	1.1x10 ³	3.0x10 ⁴
Te-129		0.6	16.2	0.5	13.5	7.7x10 ⁵	2.1x10 ⁷

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Te-131m		0.7	18.9	0.5	13.5	3.0x10 ⁴	8.0x10 ⁵
Te-132		0.4	10.8	0.4	10.8	1.1x10 ⁴	3.0x10 ⁵
Th-227	Thorium(90)	9	243	1x10 ⁻²	0.270	1.1x10 ³	3.1x10 ⁴
Th-228		0.3	8.11	4x10 ⁻⁴	1.08x10 ⁻²	3.0x10 ¹	8.2x10 ²
Th-229		0.3	8.11	3x10 ⁻⁵	8.11x10 ⁻⁴	7.9x10 ⁻³	2.1x10 ⁻¹
Th-230		2	54.1	2x10 ⁻⁴	5.41x10 ⁻³	7.6x10 ⁻⁴	2.1x10 ⁻²
Th-231		40	1080	0.9	24.3	2.0x10 ⁴	5.3x10 ⁵
Th-232		Unlimited	Unlimited	Unlimited	Unlimited	4.0x10 ⁻⁹	1.1x10 ⁻⁷
Th-234		0.2	5.41	0.2	5.41	8.6x10 ²	2.3x10 ⁴
Th (natural)		Unlimited	Unlimited	Unlimited	Unlimited	8.1x10 ⁻⁹	2.2x10 ⁻⁷
Ti-44	Titanium(22)	0.5	13.5	0.2	5.41	6.4	1.7x10 ²
Tl-200	Thallium(81.1)	0.8	21.6	0.8	21.6	2.2x10 ⁴	6.0x10 ⁵
Tl-201		10	270	10	270	7.9x10 ³	2.1x10 ⁵
Tl-202		2	54.1	2	54.1	2.0x10 ³	5.3x10 ⁴
Tl-204		4	108	0.5	13.5	1.7x10 ¹	4.6x10 ²
Tm-167	Thulium(69)	7	189	7	189	3.1x10 ³	8.5x10 ⁴
Tm-168		0.8	21.6	0.8	21.6	3.1x10 ²	8.3x10 ³
Tm-170		4	108	0.5	13.5	2.2x10 ²	6.0x10 ³
Tm-171		40	1080	10	270	4.0x10 ¹	1.1x10 ³
U-230	Uranium(92)	40	1080	1x10 ⁻²	0.270	1.0x10 ³	2.7x10 ⁴
U-232		3	81.1	3x10 ⁻⁴	8.11x10 ⁻³	8.3x10 ⁻¹	2.2x10 ¹
U-233		10	270	1x10 ⁻³	2.70x10 ⁻²	3.6x10 ⁻⁴	9.7x10 ⁻³
U-234		10	270	1x10 ⁻³	2.70x10 ⁻²	2.3x10 ⁻⁴	6.3x10 ⁻³
U-235		Unlimited	Unlimited	Unlimited	Unlimited	8.0x10 ⁻⁸	2.2x10 ⁻⁶

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
U-236		10	270	1x10 ⁻³	2.70x10 ⁻²	2.4x10 ⁻⁶	6.5x10 ⁻⁵
U-238		Unlimited	Unlimited	Unlimited	Unlimited	1.2x10 ⁻⁸	3.4x10 ⁻⁷
U (natural)		Unlimited	Unlimited	Unlimited	Unlimited	2.6x10 ⁻⁸	7.1x10 ⁻⁷
U (enriched 5% or less)		Unlimited	Unlimited	Unlimited	Unlimited	--	(see Table A-3)
U (enriched more than 5%)		10	270	1x10 ⁻³	2.70x10 ⁻²	--	(see Table A-3)
U (depleted)		Unlimited	Unlimited	Unlimited	Unlimited	--	(see Table A-3)
V-48	Vanadium(23)	0.3	8.11	0.3	8.11	6.3x10 ³	1.7x10 ⁵
V-49		40	1080	40	1080	3.0x10 ²	8.1x10 ³
W-178	Tungsten(74)	1	27.0	1	27.0	1.3x10 ³	3.4x10 ⁴
W-181		30	811	30	811	2.2x10 ²	6.0x10 ³
W-185		40	1080	0.9	24.3	3.5x10 ²	9.4x10 ³
W-187		2	54.1	0.5	13.5	2.6x10 ⁴	7.0x10 ⁵
W-188		0.2	5.41	0.2	5.41	3.7x10 ²	1.0x10 ⁴
Xe-122	Xenon(54)	0.2	5.41	0.2	5.41	4.8x10 ⁴	1.3x10 ⁶
Xe-123		0.2	5.41	0.2	5.41	4.4x10 ⁵	1.2x10 ⁷
Xe-127		4	108	4	108	1.0x10 ³	2.8x10 ⁴
Xe-131m		40	1080	40	1080	3.1x10 ³	8.4x10 ⁴
Xe-133		20	541	20	541	6.9x10 ³	1.9x10 ⁵
Xe-135		4	108	4	108	9.5x10 ⁴	2.6x10 ⁶
Y-87	Yttrium(39)	2	54.1	2	54.1	1.7x10 ⁴	4.5x10 ⁵
Y-88		0.4	10.8	0.4	10.8	5.2x10 ²	1.4x10 ⁴

Symbol of Radionuclide	Element and Atomic Number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific (TBq/g)	Activity (Ci/g)
Y-90		0.2	5.41	0.2	5.41	2.0x10 ⁴	5.4x10 ⁵
Y-91m		2	54.1	2	54.1	1.5x10 ⁶	4.2x10 ⁷
Y-91		0.3	8.11	0.3	8.11	9.1x10 ²	2.5x10 ⁴
Y-92		0.2	5.41	0.2	5.41	3.6x10 ⁵	9.6x10 ⁶
Y-93		0.2	5.41	0.2	5.41	1.2x10 ⁵	3.3x10 ⁶
Yb-169	Ytterbium(70)	3	81.1	3	81.1	8.9x10 ²	2.4x10 ⁴
Yb-175		30	811	0.9	24.3	6.6x10 ³	1.8x10 ⁵
Zn-65	Zinc(30)	2	54.1	2	54.1	3.0x10 ²	8.2x10 ³
Zn-69m		2	54.1	0.5	13.5	1.2x10 ⁵	3.3x10 ⁶
Zn-69		4	108	0.5	13.5	1.8x10 ⁶	4.9x10 ⁷
Zr-88	Zirconium(40)	3	81.1	3	81.1	6.6x10 ²	1.8x10 ⁴
Zr-93		40	1080	0.2	5.41	9.3x10 ⁻⁵	2.5x10 ⁻³
Zr-95		1	27.0	0.9	24.3	7.9x10 ²	2.1x10 ⁴
Zr-97		0.3	8.11	0.3	8.11	7.1x10 ⁴	1.9x10 ⁶

^a International shipments of Einsteinium require multilateral approvals of A₁ and A₂ values.

^b International shipments of Fermium require multilateral approvals of A₁ and A₂ values.

^c 20 curies for Mo⁹⁹ for domestic use.

^d Also, for liquids only, a concentration limit of not greater than 1 TBq/liter (27 Curies/liter).

EDITOR'S NOTE: The specific activity in quotes for Rhenium (natural) in TBq/g and U-234 in TBq/g and Ci/g is calculated by the editor. These values were left blank in 10 CFR Part 71 Appendix A.

Table A-2 General Values for A₁ and A₂

Contents	A ₁		A ₂	
	(TBq)	(Ci)	(TBq)	(Ci)
Only beta- or gamma-emitting nuclides are known to be present	0.2	5	0.02	0.5
Alpha-emitting nuclides are known to be present, or no relevant data are available.	0.10	2.7	2x10 ⁻⁵	5.41x10 ⁻⁴

Table A-3 Activity-mass Relationships for Uranium

Uranium Enrichment* wt % U-235 present	Specific Activity	
	TBq/g	Ci/g
0.45	1.8x10 ⁻⁸	5.0x10 ⁻⁷
0.72	2.6x10 ⁻⁸	7.1x10 ⁻⁷
1.0	2.8x10 ⁻⁸	7.6x10 ⁻⁷
1.5	3.7x10 ⁻⁸	1.0x10 ⁻⁶
5.0	1.0x10 ⁻⁷	2.7x10 ⁻⁶
10.0	1.8x10 ⁻⁷	4.8x10 ⁻⁶
20.0	3.7x10 ⁻⁷	1.0x10 ⁻⁵
35.0	7.4x10 ⁻⁷	2.0x10 ⁻⁵
50.0	9.3x10 ⁻⁷	2.5x10 ⁻⁵
90.0	2.2x10 ⁻⁶	5.8x10 ⁻⁵
93.0	2.6x10 ⁻⁶	7.0x10 ⁻⁵
95.0	3.4x10 ⁻⁶	9.1x10 ⁻⁵

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

TABLE A-4

ACTIVITY - MASS RELATIONSHIP FOR URANIUM/THORIUM

Thorium and Uranium Enrichment ¹ . wt % ²³⁵ U present	Specific Activity	
	Ci per G	g per Ci
0.45	5.0×10^{-7}	2.0×10^6
0.72 (natural)	7.06×10^{-7}	1.42×10^6
1.0	7.6×10^{-7}	1.3×10^6
1.5	1.0×10^{-6}	1.0×10^6
5.0	2.7×10^{-6}	3.7×10^5
10.0	4.8×10^{-6}	2.1×10^5
20.0	1.0×10^{-5}	1.0×10^5
35.0	2.0×10^{-5}	5.0×10^4
50.0	2.5×10^{-5}	4.0×10^4
90.0	5.8×10^{-5}	1.7×10^4
93.0	7.0×10^{-5}	1.4×10^4
95.0	9.1×10^{-5}	1.1×10^4
Natural Thorium	2.2×10^{-7}	4.6×10^6

1. The figures for uranium include representative values for the activity of the uranium 234 which is concentrated during the enrichment process. The activity for thorium includes the equilibrium concentration of thorium 228.