

DOT REGULATIONS AND TRANSPORTING OF GAUGES & SOURCES

Appendix A “Definitions”

U. S. Department of Transportation Hazardous Materials Transportation

Radioactive Materials Definitions Under 49 CFR 171

The following definitions are abstracted from Title 49 of the Code of Federal Regulations, Parts 100 - 185, Section 171.8.

CARRIER - A person engaged in the transportation of passengers or property by:

1. Land or water, as a common, contract, or private carrier, or
2. Civil aircraft.

CLASS - Means hazard class. See *hazard class*.

Class 1. See 173.50 of this subchapter.

Class 2. See 173.115 of this subchapter.

Class 3. See 173.120 of this subchapter.

Class 4. See 173.124 of this subchapter.

Class 5. See 173.128 of this subchapter.

Class 6. See 173.132 of this subchapter.

Class 7. See 173.403 of this subchapter.

(Definition of Radioactive Material)

Class 8. See 173.136 of this subchapter.

Class 9. See 173.140 of this subchapter.

GENERAL PUBLIC - For purposes of subpart I of Part 172, and subpart I of Part 173 of this subchapter, any person other than an occupationally exposed hazmat employee.

HAZARD CLASS - The category of hazard assigned to a hazardous material under the definitional criteria of Part 173 of this subchapter and the provisions of the 172.101 Table. A material may meet the defining criteria for more than one hazard class but is assigned to only one hazard class.

HAZMAT EMPLOYEE - A person who is employed by a hazmat employer and who, in the course of employment, directly affects hazardous materials transportation safety. This term includes an owner-operator of a motor vehicle which transports hazardous materials in commerce. This term includes an individual, including a self-employed individual, employed by a hazmat employer who, during the course of employment:

1. Loads, unloads, or handles hazardous materials;
2. Manufactures, tests, reconditions, repairs, modifies, marks, or otherwise represents containers, drums, or packagings as qualified for use in the transportation of hazardous materials;
3. Prepares hazardous materials for transportation;
4. Is responsible for safety or transporting hazardous materials; or
5. Operates a vehicle used to transport hazardous materials.

HAZMAT EMPLOYER - A person who uses one or more of its employees in connection with: Transporting hazardous materials in commerce; causing hazardous materials to be transported or shipped in commerce; or representing, marking, certifying, selling, offering, manufacturing, reconditioning, testing, repairing, or modifying containers, drums, or packagings as qualified for use in the transportation of hazardous materials. This term includes an owner-operator of a motor vehicle that transports hazardous materials in commerce. This term also includes any department, agency, or instrumentality of the United States, a State, a political subdivision of a State, or an Indian tribe engaged in an activity described in the first sentence of this definition.

LIMITED QUANTITY - When specified as such in a section applicable to a particular material, means the maximum amount of a hazardous material for which there is a specific labeling or packaging exception.

NAME OF CONTENTS - The proper shipping name as specified in 172.101 of this subchapter.

N.O.S. - Means not otherwise specified.

N.O.S. DESCRIPTION - A shipping description from the 172.101 table which includes the abbreviation n.o.s., and as contained in the lists in 172.203(k)(3) of this subchapter, regarding additional description requirements.

OCCUPATIONALLY EXPOSED HAZMAT EMPLOYEE - A hazmat employee whose duties involve exposure to ionizing radiation.

PREFERRED ROUTE or PREFERRED HIGHWAY - A highway for shipment of *highway route controlled quantities* of radioactive materials so designated by a State routing agency, and any Interstate System highway for which an alternative highway has not been designated by such State agency as provided by 177.825(b) of this subchapter.

PROPER SHIPPING NAME - The name of the hazardous material shown in Roman print (not italics) in 172.101 of this subchapter.

RADIOACTIVE MATERIALS - See 173.403 of this subchapter for definitions relating to radioactive materials.

REPORTABLE QUANTITY (RQ) - For the purposes of this subchapter means the quantity specified in Column 3 of the appendix to 172.101 for any material identified in Column 1 of the appendix.

SHIPPING PAPER - A shipping order, bill of lading, manifest or other shipping document serving a similar purpose and containing the information required by 172.202, 172.203 and 172.204.

TRANSPORT VEHICLE - A cargo-carrying vehicle such as an automobile, van, tractor, truck, semi-trailer, tank car or rail car used for the transportation of cargo by any mode. Each cargo-carrying body (trailer, rail car, etc.) is a separate transport vehicle.

Appendix A “Definitions” (continued)

U. S. Department of Transportation Hazardous Materials Transportation

Radioactive Materials Definitions Under 49 CFR 173

The following definitions are abstracted from Title 49 of the Code of Federal Regulations, Parts 100 - 185, Section 173.403.

For purposes of this subpart -----

A₁ - The maximum activity of special form Class 7 (radioactive) material permitted in a Type A package.

A₂ - The maximum activity of Class 7 (radioactive) material, other than special form, LSA or SCO, permitted in a Type A package. These values are either listed in 173.435 or derived in accordance with the procedure prescribed in 173.433.

Class 7 (RADIOACTIVE) MATERIAL - See the definition of *Radioactive material* in this section.

CLOSED TRANSPORT VEHICLE - A transport vehicle or conveyance equipped with a securely attached exterior enclosure that during normal transportation restricts the access of unauthorized persons to the cargo space containing the Class 7 (radioactive) materials. The enclosure may be either temporary or permanent, and in the case of packaged materials may be of the “see-through” type, and must limit access from top, sides, and bottom.

CONSIGNMENT – means a package or group of packages or load of radioactive material offered by a person for transport in the same shipment.

CONTAINMENT SYSTEM - The assembly of components of the packaging intended to retain the Class 7 (radioactive) material during transport.

CONTAMINATION - means the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters or 0.04 Bq/cm² for all other alpha emitters. Contamination exists in two phases.

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

(2) Non-fixed radioactive contamination means radioactive 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 aircraft, any aircraft.

CRITICALITY SAFETY INDEX (CSI) - means a number (rounded up to the next tenth) which is used to provide control over the accumulation of packages, overpacks or freight containers containing fissile material.

The CSI for packages containing fissile material is determined in accordance with the instructions provided in 10 CFR 71.22, 71.23, and 71.59. The CSI for an overpack, freight container, or consignment 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, or consignment.

DESIGN - The description of a special form Class 7 (radioactive) material, a package, packaging, or LSA-III, that enables those items to be fully identified. The description may include specifications, engineering drawings, reports showing compliance with regulatory requirements, and other relevant documentation.

EXCLUSIVE USE - means 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 provide to the initial carrier specific written instructions for maintenance of exclusive use shipment controls, including the vehicle survey requirement of Sec. 173.443 (c) as applicable, and include these instructions with the shipping paper information provided to the carrier by the consignor.

EXEMPTION VALUE - means either an exempt material activity concentration or an exempt consignment activity limit listed in the table in Sec. 173.436, or determined according to the procedures described in Sec. 173.433, and used to determine whether a given physically radioactive material is sufficiently radioactive to be subject to the HMR (see definition of radioactive material). An exemption value is different from an exemption, as defined in Sec. 171.8 of this subchapter.

FISSILE MATERIAL - Plutonium-238, plutonium-239, plutonium-241, uranium-233, uranium-235, or any combination of these radionuclides. The definition does not apply to unirradiated natural uranium and depleted uranium, and natural uranium or depleted uranium that has been irradiated in a thermal reactor. Certain additional exceptions are provided in 173.453.

FISSILE MATERIAL - CONTROLLED SHIPMENT - Any shipment that contains one or more packages that have been assigned, in accordance with 173.457, nuclear criticality control transport indices greater than 10.

FREIGHT CONTAINER - A reusable container having a volume of 1.81 cubic meters (64 cubic feet) or more, designed and constructed to permit its being lifted with its contents intact and intended primarily for containment of packages in unit form during transportation. A “small freight container” is one which has either one outer dimension less than 1.5 meters (4.9 feet) or an internal volume of not more than 3.0 cubic meters (106 cubic feet). All other freight containers are designated as “large freight containers.”

HIGHWAY ROUTE CONTROLLED QUANTITY - A quantity within a single package which exceeds:

1. 3,000 times the A_1 value of the radionuclides as specified in 173.435 for special form Class 7 (radioactive) material;
2. 3,000 times the A_2 value of the radionuclides as specified in 173.435 for normal form Class 7 (radioactive) material; or
3. 1,000 TBq (27,000 Ci), whichever is least.

LIMITED QUANTITY OF CLASS 7 (RADIOACTIVE) MATERIAL - A quantity of Class 7 (radioactive) material not exceeding the materials package limits specified in 173.425 and conforming with requirements specified in 173.421.

LOW SPECIFIC ACTIVITY (LSA) MATERIAL - Class 7 (radioactive) material with limited specific activity that satisfies the descriptions and limits set forth below. Shielding materials surrounding the LSA material may not be considered in determining the estimated average specific activity of the package contents. LSA material must be in one of three groups:

1. LSA I

- (i) Ores containing only naturally occurring radionuclides (e.g., uranium, thorium) and uranium or thorium concentrates of such ores; or
- (ii) Solid unirradiated natural uranium or depleted uranium or natural thorium or their solid or liquid compounds or mixtures; or
- (iii) Class 7 (radioactive) material, other than fissile material, for which the A_2 value is unlimited; or
- (iv) Mill tailings, contaminated earth, concrete, rubble, other debris, and activated material in which the Class 7 (radioactive) material is essentially uniformly distributed and the average specific activity does not exceed $10^{-6}A_2/g$.

2. LSA-II

- (i) Water with tritium concentration up to 0.8 TBq/liter (20.0 Ci/liter); or
- (ii) Material in which the Class 7 (radioactive) material is essentially uniformly distributed and the average specific activity does not exceed $10^{-4}A_2/g$ for solids and gases, and $10^{-5}A_2/g$ for liquids.

3. LSA-III

Solids (e.g. consolidated wastes, activated materials) that meet the requirements of 173.468 and which:

- (i) The Class 7 (radioactive) material is essentially uniformly distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.); and
- (ii) The Class 7 (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 Class 7 (radioactive) material per package by leaching when placed in water for seven days would not exceed $0.1A_2$; and
- (iii) The average specific activity of the solid does not exceed $2 \times 10^{-3}A_2/g$.

LOW TOXICITY ALPHA EMITTERS - are:

- 1. Natural uranium, depleted uranium, and natural thorium;
- 2. Ores, concentrates or tailings containing uranium-235, uranium-238, thorium-232, thorium-228 and thorium-230; or
- 3. Alpha emitters with a half-life of less than 10 days.

MAXIMUM NORMAL OPERATING PRESSURE - The maximum gauge pressure that would develop in a receptacle in a period of one year, in the absence of venting or cooling, under the head conditions specified in 10 CFR 71.71(c)(1).

MULTILATERAL APPROVAL - Approval of a package or shipment by the relevant competent authority of the country of origin and of each country through or into which the package or shipment is to be transported. This definition does not include approval from a country over which Class 7 (radioactive) materials are carried in aircraft, if there is no scheduled stop in that country.

NATURAL THORIUM - Thorium with the naturally occurring distribution of thorium isotopes (essentially 100 percent by weight of thorium-232).

NON-FIXED RADIOACTIVE CONTAMINATION - Radioactive contamination that can be readily removed from a surface by wiping with an absorbent material. Non-fixed (removable) radioactive contamination is not significant if it does not exceed the limits specified in 173.443.

NORMAL FORM CLASS 7 (RADIOACTIVE) MATERIAL - means Class 7 (radioactive) material which has not been demonstrated to qualify as "special form Class 7 (radioactive) material."

PACKAGE - means the packaging together with its radioactive contents as presented for transport.

(1) "Excepted package" means a packaging together with its excepted Class 7 (radioactive) materials as specified in Sec. 173.421-173.426 and 173.428.

(2) "Industrial package" means a packaging that, together with its low specific activity (LSA) material or surface contaminated object (SCO) contents, meets the requirements of Sec. 173.410 and 173.411. Industrial packages are categorized in Sec. 173.411 as either:

- (i) "Industrial package Type 1 (IP-1)";
- (ii) "Industrial package Type 2 (IP-2)"; or
- (iii) "Industrial package Type 3 (IP-3)".

(3) "Type A package" means a packaging that, together with its radioactive contents limited to A1 or A2 as appropriate, meets the requirements of Sec. 173.410 and 173.412 and is designed to retain the integrity of containment and shielding required by this part under normal conditions of transport as demonstrated by the tests set forth in Sec. 173.465 or Sec. 173.466, as appropriate. A Type A package does not require Competent Authority approval.

(4) "Type B package" means a packaging designed to transport greater than an A1 or A2 quantity of radioactive material that, together with its radioactive contents, is designed to retain the integrity of containment and shielding required by this part when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR part 71.

(i) "Type B(U) package" means a Type B packaging that, together with its radioactive contents, for international shipments requires unilateral approval only of the package design and of any stowage provisions that may be necessary for heat dissipation.

(ii) "Type B(M) package" means a Type B packaging, together with its radioactive contents, that for international shipments requires multilateral approval of the package design, and may require approval of the conditions of shipment. Type B(M) packages are those Type B package designs which have a maximum normal operating pressure of more than 700 kPa/cm² (100 lb/in²) gauge or a relief device which would allow the release of Class 7 (radioactive) material to the environment under the hypothetical accident conditions specified in 10 CFR part 71.

(5) "Fissile material package" means a packaging, together with its fissile material contents, which meets the requirements for fissile material packages described in subpart E of 10 CFR 71. A fissile material package may be a Type AF package, a Type B(U)F package, or a Type B(M)F package.

PACKAGING - For Class 7 (radioactive) materials, the assembly of components necessary to ensure compliance with the packaging requirements of this subpart. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, service equipment for filling, emptying, venting and pressure relief, and devices for cooling or absorbing mechanical shocks. The conveyance, tie-down system, and auxiliary equipment may sometimes be designated as part of the packaging.

RADIATION LEVEL - The radiation dose-equivalent rate expressed in millisievert(s) per hour or mSv/h (millirem(s) per hour or mrem/h). Neutron flux densities may be converted into radiation levels according to Table 1.

RADIOACTIVE CONTENTS - A Class 7 (radioactive) material, together with any contaminated liquids or gases within the package.

RADIOACTIVE INSTRUMENT and ARTICLE - Any manufactured instrument and article such as an instrument, clock, electronic tube or apparatus, or similar instrument and article having Class 7 (radioactive) material in gaseous or non-dispersible solid form as a component part.

RADIOACTIVE MATERIAL - means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in the table in Sec. 173.436 or values derived according to the instructions in Sec. 173.433.

SPECIAL FORM CLASS 7 (RADIOACTIVE) MATERIAL - means either an indispersible solid radioactive material or a sealed capsule containing radioactive material which satisfies the following conditions:

- (1) It is either a single solid piece or a sealed capsule containing radioactive material that can be opened only by destroying the capsule;
- (2) The piece or capsule has at least one dimension not less than 5 mm (0.2 in); and
- (3) It satisfies the test requirements of Sec. 173.469. Special form encapsulations designed in accordance with the requirements of Sec. 173.389(g) in effect on June 30, 1983 (see 49 CFR part 173, revised as of October 1, 1982), and constructed prior to July 1, 1985 and special form encapsulations designed in accordance with the requirements of Sec. 173.403 in effect on March 31, 1996 (see 49 CFR part 173, revised as of October 1, 1995), and constructed prior to April 1, 1997, may continue to be used. Any other special formencapsulation must meet the requirements of this paragraph (3).

SPECIFIC ACTIVITY - The specific activity of a radionuclide means the activity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the activity per unit mass of the material.

SURFACE CONTAMINATED OBJECT (SCO) - A solid object that is not itself radioactive but which has Class 7 (radioactive) material distributed on any of its surfaces. SCO must be in one of two groups with surface activity not exceeding the following limits:

1. SCO-I: A solid object on which:

- (i) 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 4 Bq/cm² for beta and gamma and low toxicity alpha emitters, or 0.4 Bq/cm² for alpha emitters;
- (ii) The fixed contamination on the accessible surface averaged over 300 cm² does not exceed 4 x 10⁴ Bq/cm² for beta and gamma and low toxicity alpha emitters, or 4 x 10³ Bq/cm² for all other alpha emitters; and
- (iii) The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm² does not exceed 4 x 10⁴ Bq/cm² for beta and gamma and low toxicity alpha emitters, or 4 x 10³ Bq/cm² for all other alpha emitters.

2. SCO-II: A solid object on which the limits for SCO-I are exceeded and on which:

- (i) The non-fixed contamination on the accessible surface averaged over 300 cm² does not exceed 400 Bq/cm² for beta and gamma and low toxicity alpha emitters or 40 Bq/cm² for all other alpha emitters;
- (ii) The fixed contamination on the accessible surface averaged over 300 cm² does not exceed 8 x 10⁵ Bq/cm² for beta and gamma and low toxicity alpha emitters, or 8 x 10⁴ Bq/cm² for all other alpha emitters; and
- (iii) The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm² does not exceed 8 x 10⁵ Bq/cm² for beta and gamma and low toxicity alpha emitters, or 8 x 10⁴ Bq/cm² for all other alpha emitters.

TRANSPORT INDEX (TI) - means the dimensionless number (rounded up to the next tenth) placed on the label of a package, to designate the degree of control to be exercised by the carrier during transportation. The transport index is determined by multiplying the maximum radiation level in millisieverts (mSv) per hour at 1 m (3.3 ft) from

the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at 1 m (3.3 ft)).

TYPE A QUANTITY - means a quantity of Class 7 (radioactive) material, the aggregate radioactivity which does not exceed A1 for special form Class 7 (radioactive) material or A2 for normal form Class 7 (radioactive) material, where A1 and A2 values are given in Sec.173.435 or are determined in accordance with Sec.173.433.

TYPE B QUANTITY - A quantity of material greater than a Type A quantity.

UNILATERAL APPROVAL - Approval of a package solely by the competent authority of the country of origin.

UNIRRADIATED THORIUM - Thorium containing not more than 10^{-7} grams uranium-233 per gram of thorium-232.

UNIRRADIATED URANIUM - Uranium containing not more than 10^{-6} grams plutonium per gram of uranium-235 and a fission product activity of not more than 9 MBq of fission products per gram of uranium-235.

URANIUM - NATURAL, DEPLETED OR ENRICHED -

1. “*Natural uranium*” means uranium with the naturally occurring distribution of uranium isotopes.
2. “*Depleted uranium*” means uranium containing less uranium-235 than the naturally occurring distribution of uranium isotopes.
3. “*Enriched uranium*” means uranium containing more uranium-235 than the naturally occurring distribution of uranium isotopes.

Appendix B

TRAINING REQUIREMENTS FOR HAZARDOUS MATERIAL EMPLOYEES (Ref. 49 CFR 172 Subpart H)

A. Who needs training?

Each hazmat employee who assists in the preparation and delivery of radioactive material packages needs training.

B. The training program shall ensure that a hazmat employee is (Ref. 49 CFR 172.700(b)):

- ⇒ Familiar with the general provisions of the DOT regulations, 49 CFR Parts 171-180
- ⇒ Able to recognize and identify hazardous materials
- ⇒ Knowledgeable of DOT requirements applicable to functions performed by the hazmat employee
- ⇒ Knowledgeable in emergency self-protection measures and accident prevention methods and procedures

C. Applicability and Responsibility for Training and Testing (Ref. 172.702)

- ⇒ Employer shall ensure that each hazmat employee is trained
- ⇒ Employee may not perform any function subject to DOT regulations without training
- ⇒ Training may be provided by anyone
- ⇒ Testing by appropriate means on the training subjects in 172.704

D. Training Requirements (172.704)

Training shall include:

- ⇒ General awareness/familiarization training
- ⇒ Function-specific training

For example, a hazmat employee job requires him/her to block and brace packages so they cannot change position during conditions normally incident to transportation as required by 177.842(d).

- ⇒ Safety training

Emergency response information measures to protect employee methods and procedures to avoid accidents.

- ⇒ Other training may be used to satisfy the training requirements but must address the training in 172.704(a).

E. Training Frequency

1. Initial Training

- a) If employed after 7/2/93, complete training within 90 days after employment, or
- b) Complete training within 90 days after changing hazardous materials job functions.
- c) Hazmat employee should be supervised when performing new hazardous materials job functions if training is not completed.

2. Recurrent Training

Hazmat employee shall receive training once every three (3) years.

3. Previous employer training may be used, if a record of the training is obtained.

4. Maintain training records as long as employee is employed and for 90 days thereafter.

5. Training record shall include:

- Hazmat employee name
- Most recent training completion date
- Description, copy, or the location of training materials
- Name and address of the person providing training; and
- Certification that the hazmat employee has been trained and tested.

F. 49 CFR 177.800 (c) prohibits private, common or contract carriers from transporting a hazardous material by motor vehicle unless each of its hazmat employees involved in that transportation is trained as required by 49 CFR 172 Subpart H.

Appendix C Packaging, Marking and Labeling

PACKAGING REQUIREMENTS

A. Package Limits

1. Excepted Packages

- a. Class 7 (radioactive) materials for limited quantities, instruments, and articles shall not exceed the materials package limits specified in 173.425 (see below).

§ 173.425 Table of activity limits—excepted quantities and articles.

The limits applicable to instruments, articles, and limited quantities subject to exceptions under §§173.421 and 173.424 are set forth in table 4 as follows:

Table 4—Activity Limits for Limited Quantities, Instruments, and Articles

Nature of contents	Instruments and articles		Limited quantity package limits ¹
	Limits for each instrument or article ¹	Package limits ¹	
Solids:			
Special form	$10^{-2}A_1$	A_1	$10^{-3}A_1$
Normal form	$10^{-2}A_2$	A_2	$10^{-3}A_2$
Liquids:			
Tritiated water:			
<0.0037 TBq/L (0.1 Ci/L)			37 TBq (1,000 Ci)
0.0037 TBq to 0.037 TBq/L (0.1 Ci to 1.0 Ci/L)			3.7 TBq (100 Ci)
>0.037 TBq/L (1.0 Ci/L)			0.037 TBq (1.0Ci)
Other Liquids	$10^{-3}A_2$	$10^{-1}A_2$	$10^{-4}A_2$
Gases:			
Tritium ²	$2 \times 10^{-2}A_2$	$2 \times 10^{-1}A_2$	$2 \times 10^{-2}A_2$
Special form	$10^{-3}A_1$	$10^{-2}A_1$	$10^{-3}A_1$
Normal form	$10^{-3}A_2$	$10^{-2}A_2$	$10^{-3}A_2$

¹For mixtures of radionuclides see §173.433(d).

²These values also apply to tritium in activated luminous paint and tritium adsorbed on solid carriers.

Example: What is the material package limit for a special form and a normal form excepted package of solid Cs-137? From Appendix C, Page 35, the A_1 (Special Form) and A_2 (Normal Form) values are 54.1 Curies and 13.5 Curies, respectively.

Answer: Special Form = $(10^{-3})(54.1 \text{ Ci}) = 0.0541 \text{ Ci}$ or 54.1 mCi

Normal Form = $(10^{-3})(13.5 \text{ Ci}) = 0.0135 \text{ Ci}$ or 13.5 mCi

- b. If the calculated activity exceeds the package limits from Table 7 of 173.425, the radioactive material cannot be shipped in an excepted package and therefore, must be shipped in a Type A or Type B package.
 - 2. Type A Package Limits
 - a. Class 7 (radioactive) material that does not exceed the A₁ (special form) or A₂ (normal form) activity limits, as appropriate.
 - b. A₁ and A₂ activity limits may be determined in accordance with 173.433.
 - c. If the A₁ or A₂ activity value is exceeded the radioactive material cannot be shipped in a Type A package and therefore, must be shipped in a Type B package.
 - 3. Type B Package Limits
 - a. A quantity of Class 7 (radioactive) material greater than a Type A quantity.
 - 4. Industrial Package Limits
 - a. Class 7 (radioactive material) with limited specific activity defined as LSA-I, LSA-II, and/or LSA-III.
 - b. Surface Contaminated Objects (SCO) defined as SCO-I and SCO-II.
- B. Packaging Design
- 1. Excepted Packages must meet the following criteria:
 - a. Meet the general design requirements in 173.410.
 - 1) Package can be easily handled and properly secured in or on a conveyance;
 - 2) Package lifting attachments must be designed with a minimum safety factor;
 - 3) External surfaces will be free of protruding features;
 - 4) Outer packaging layer will avoid pockets and crevices;
 - 5) Package must be capable of withstanding the effects of any acceleration, vibration, or vibration resonance (see 49 CFR 178.608); and
 - 6) Construction materials shall be physically and chemically compatible with each other and the contents;
 - 7) Values protected against unauthorized operations.
 - 8) Additional requirements in subpart A and B of 49 CFR 173.
 - b. Meet the requirements of 49 CFR 173.421 (Limited Quantities).

Please note that some of the following requirements will defer for radioactive materials shipped as instruments and articles (173.424), articles containing natural uranium or thorium (173.426) or empty class 7 radioactive material (173.428).

 - 1) Radiation level at any point on the external surface of the package does not exceed 0.005 mSv/hr (0.5 mR/hr);

- 2) Non-fixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in 173.443(a).
- 3) The outside of the inner package or; if there is no inner package, the outside of the package itself bears the marking “*Radioactive*”.
- 4) Package shall not contain more than 15 grams of U-235 except as provided in 173.426; and

c. Additional Requirements in 173.422 for Excepted Packages:

- 1) Must be certified as being acceptable for transportation by having a notice enclosed in or on the package, included with the packing list, or otherwise forwarded with the package. This notice must include the name of the consignor or consignee and one of the statements in 173.422(a) 1-4, as appropriate.

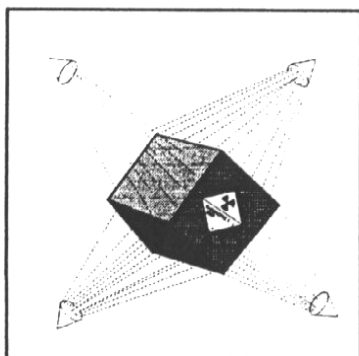
Example: “This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910.”

- 2) Must follow the reporting of incidents and decontamination in 49 CFR 171.15, 171.16, 174.750, 175.45, 175.700(b), 176.710, and 177.861.

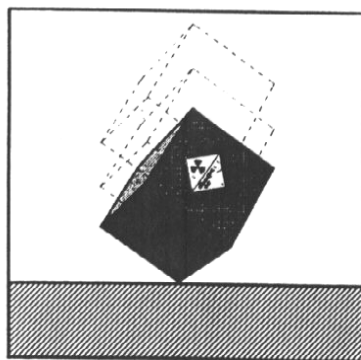
2. Type A Package Design

- a. The package performance requirements and tests shall prevent loss or dispersal of contents and significant increase in the radiation levels if subject to normal conditions of transport including rough handling.
- b. Must meet the general design requirements in 49 CFR 173.410 and 173.412.
- c. Packaging with contents must be capable of withstanding the following tests from 173.465. (Note: Additional tests for Type A packagings designed for liquids and gases are in 173.466.)

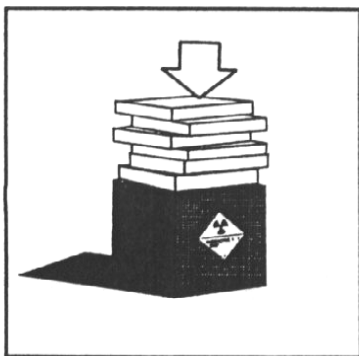
TYPE A PACKAGE TESTS INCLUDE:



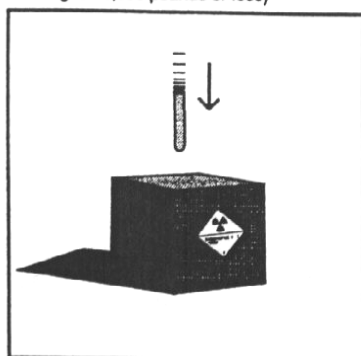
1. Water spray test for 1 hour (to simulate rainfall of 2 inches per hour)



2. Free-fall drop test onto a flat hard surface (a four foot drop if the package weighs 11,000 pounds or less)



3. Compression test of 5 times the weight of the package for at least 24 hours



4. Penetration test by dropping a 13-pound bar (1-1/4 inch diameter) vertically onto the package from a height of 3.3 feet

1. *Water Spray Test:* The water spray test must precede each test or test sequence prescribed in this section. The water spray test must simulate exposure to rainfall of approximately 5 centimeters (2 inches) per hour for at least one hour. The time interval between the end of the water spray test and the beginning of the next test must be such that the water has soaked in to the maximum extent without appreciable drying of the exterior of the specimen. In the absence of evidence to the contrary, this interval may be assumed to be two hours if the water spray is applied from four different directions simultaneously. However, no time interval may elapse if the water spray is applied from each of the four directions consecutively.

2. *Free Drop:* Onto a flat unyielding horizontal surface, striking in a position expected

to do the most damage. Distance varies from 1 to 4 feet based upon package weight (as if a package fell from a loading dock or back of a truck).

Corner Drop: Onto each corner in succession (or each quarter of a cylindrical rim) from a height of 1 foot onto a flat unyielding surface (for all fissile Class II packaging - and packaging weighing less than 110 lbs).

3. *Stacking Test:* The specimen must be subjected for a period of at least 24 hours to a compressive load equivalent to the greater of the following: (1) Five times the mass of the actual package; or (2) The equivalent of 13 kilopascals (1.9 pounds per square inch) multiplied by the vertically projected area of the package. The compressive load must be applied uniformly to two opposite sides of the specimen, one of which must be the base on which the package would normally rest.

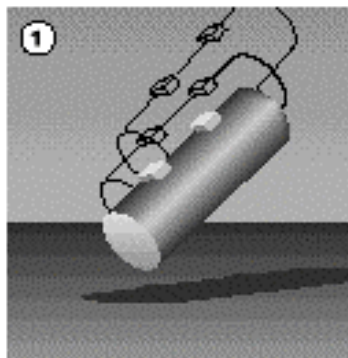
4. *Penetration Test:* A bar of 3.2 centimeters (1.3 inches) in diameter (note revised measurement) with a hemispherical end and a mass of 6 kilograms (13.2 pounds) must be dropped from a height of 1 meter (3.3 feet) or greater onto the center of the weakest part of the packaging.

- d. Type A packages approved and documented as meeting the design specifications and test requirements may be used. NOTE: Obtain a copy of the Type A package certification for your records and maintain for inspection purposes.

3. Type B Packaging Design

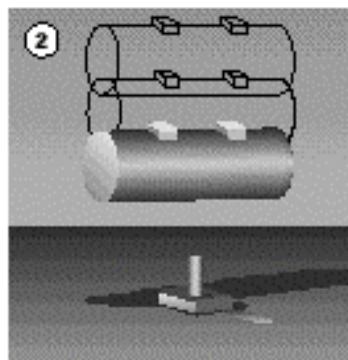
- a. Must provide an application to the NRC for Type B packaging approval. The application shall contain (10 CFR 71.31):
 - 1) Package description 10 CFR 71.33;
 - 2) Package evaluation 10 CFR 71.35;
 - 3) Quality Assurance Program 10 CFR 71.37;
 - 4) Modifications to a package must satisfy standards in effect at the time of application filing;
 - 5) Identify any established codes and standards proposed for use.
- b. The standards in 10 CFR 71 Subpart E “Package Approval Standards” and Subpart F “Package Special Form, and LSA-III Tests” must be followed for Type B packaging.
- c. In addition to passing the test requirements in 10 CFR 71.71 “Normal Conditions of Transport” the Type B package must pass the test requirements in 10 CFR 71.73 “Hypothetical Accident Conditions.” The tests under 71.73 include:

Crush: Subjection of the specimen to a dynamic crush test by positioning the specimen on a flat, essentially unyielding, horizontal surface so as to suffer maximum damage by the drop of a 500 kg (1100 pound) mass from 9 m (30 ft.) onto the specimen. The mass must consist of a solid mild steel plate 1 m (40 inch) by 1 m and must fall in a horizontal attitude. The crush test is required only when the specimen has a mass not greater than 500 kg (1100 lbs), an overall density not greater than 1000 kg/m³ (62.4 lbs/ft³) based on external dimensions, and radioactive contents greater than 1000 A₂ not as special form radioactive material. (No illustration available.)



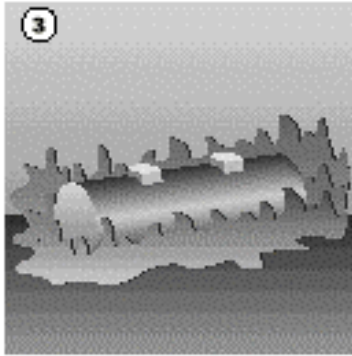
Impact test by a 9-meter (30 foot) drop onto a flat, unyielding* surface so that the package's weakest point is struck.

* Using an unyielding surface ensures that any impact will be absorbed by the package rather than the surface.

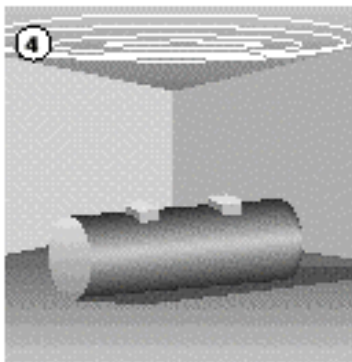


Puncture test by performing a 1-meter (40 inch) free drop onto a 15 centimeter (6-8 inch) diameter steel rod at least 20 centimeters (8 inches) long, striking the package at its most vulnerable spot.

For some low-density, lightweight packages, a dynamic crush test is required, consisting of dropping a 500-kilogram (1,100 pound) mass from 9 meters (30 feet) onto the package resting on an unyielding target.



Heat test by exposure of the entire package to 800 degrees C (1,475 degrees F) for 30 minutes



Immersion of the package under 15 meters (50 feet) of water.

For fissile materials, packages are also immersed under 0.9 meters (3 feet) of water for at least 8 hours.

PACKAGE LABELING, MARKING AND PLACARDING

- A. Subpart D of 49 CFR 172 states that each person who offers a hazardous material for transportation and each carrier that transports a hazardous material shall mark each package, freight container, and transport vehicle containing hazardous material in the manner required by Subpart D.
- B. Subpart E of 49 CFR 172 states that each person who offers for transportation or transports a hazardous material in any of the packages or containment devices shall label the package or containment device with labels specified for the material in the 172.101 Table and in Subpart E.
- C. Package Marking Requirements
 - 1. General Marking Requirements for Non-bulk Packagings (172.301)
 - a. Proper Shipping Name and Identification Number (Reference Table in 172.101, Column 2)
 - b. Consignee's or Consignor's name and address, except when transported by highway only and will not be transferred from one motor carrier to another or part of a carload lot, truckload lot, or freight container load, and the entire contents of the rail car, truck, or freight container are shipped from one consignor to one consignee.
 - c. Marking Exemptions - Identification numbers are not required on packages which contain only limited quantities.
 - 2. General Marking Requirements for Bulk Packagings (172.302)
 - a. Identification Numbers
 - 1) On each side and each end, if packaging capacity is 3785 L (1000 gallons) or more;
 - 2) On two opposing sides, if the packaging capacity is less than 3785 L (1000 gallons); or
 - 3) For cylinders permanently installed on a tube trailer motor vehicle on each side and each end of the motor vehicle.
 - b. Exemption Packagings - Durably marked "DOT-E" followed by the exemption number assigned.
 - 3. Prohibited Marking (172.303)

Cannot transport a package marked with the proper shipping name or identification number unless the package contains the identified hazardous material or its residue.
 - 4. Sec. 173.422 Additional requirements for excepted packages containing Class 7 (radioactive)

An excepted package of Class 7 (radioactive) material that is prepared for shipment under the provisions of Sec. 173.421, Sec. 173.424, Sec. 173.426, or Sec. 173.428 is not subject to any additional requirements of this subchapter, except for the following:

 - (a) The outside of each package must be marked with the four digit UN identification number for the material preceded by the letters UN, as shown in column (4) of the Hazardous Materials Table in Sec. 172.101 of this subchapter;

- (b) Sections 171.15 and 171.16 of this subchapter, pertaining to the reporting of incidents;
- (c) Sections 174.750, 175.700(b), and 176.710 of this subchapter (depending on the mode of transportation), pertaining to the reporting of decontamination;
- (d) The training requirements of subpart H of part 172 of this subchapter; and
- (e) For materials that meet the definition of a hazardous substance or a hazardous waste, the shipping paper requirements of subpart C of part 172 of this subchapter.

D. Package Labeling Requirements

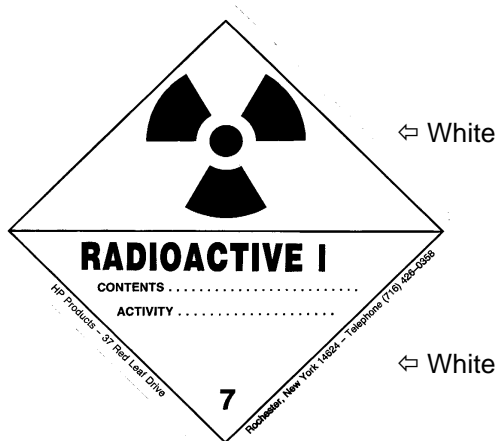
1. The labeling requirements pertain to non-bulk packaging and bulk packaging unless otherwise stated in 172.400.
2. There are certain exemptions for labeling a package of low specific activity (LSA) radioactive material when transported under 173.427 and limited quantities when the package and contents meet the requirements in 173.421 through 173.426.
3. No person or carrier may transport a package bearing a hazard material label unless the package contains a material that is a hazardous material and the label represents a hazard of the hazardous material in the package.
4. Label Specifications (172.407)
 - a. Durability
 - b. Design
 - c. Size
 - d. Color
 - e. Form Identification
 - f. Exceptions
 - g. Trefoil Symbol

Radioactive White I

Radioactive Yellow II

Radioactive Yellow III
5. Labeling of Class 7 Radioactive Material (172.403).
 - a. Proper label is based on the radiation level at the surface of the package (highest reading from all six sides) and the transport index (TI) (exposure rate at one meter from the package surface).
 - b. The label to be applied is determined by the following exposure rates for each label category:

RADIOACTIVE MATERIAL LABELS



⇨ White

⇨ White

Radioactive White I

TI: 0²

Maximum radiation level at any point on the external surface:

≤0.005 mSv/hr (0.5 mR/hr)



⇨ Yellow

⇨ White

Radioactive Yellow II

TI: More than 0 but not more than 1

Maximum radiation level at any point on the external surface:

>0.005 mSv/hr (0.5 mR/hr) but

≤0.5 mSv/hr (50 mR/hr)



⇨ Yellow

⇨ White

Radioactive Yellow III

TI: More than 1 but not more than 10

Maximum radiation level at any point on the external surface:

>0.5 mSv/hr (50 mR/hr) but

≤2 mSv/hr (200 mR/hr)

NOTE: TI: More than 10 or;

Maximum radiation level at any point on the external surface:

>2 mSv/hr (200 mR/hr) but

≤10 mSv/hr (1000 mR/hr).

Must be shipped under exclusive use provisions in 173.441(b).

E. Placarding of Shipments (Subpart F of 49 CFR 172)

Vehicle placarding is required on all four sides (front, back, and two sides) of the vehicle for Class 7 radioactive material shipments of Radioactive Yellow III labeled packages and for exclusive use shipments of low specific activity material and surface contaminated objects.

Appendix D

SHIPPING PAPERS AND SHIPPER CERTIFICATION

- A. Subpart C of 49 CFR 172 states that each person who offers a hazardous material for transportation shall describe the hazardous material on the shipping paper in the manner required.
- B. General Entries on Shipping Papers (172.201)
 - 1. Contents: The hazardous material description entries required by 172.202 and 172.203 must be entered first, or entered in color, or must be identified by the entry of an “X” placed before the proper shipping name in a column captioned “HM” (The “X” may be replaced by “RQ” if it is a Reportable Quantity; see limits in Appendix B, Page 33. The following describes the contents:
 - a. The identification number (UN) in Column 2 of the 172.201 Table. Proper shipping name prescribed for the material in Column 2 of the 172.101 Table (see Appendix A, Page 32).
 - b. Proper shipping name prescribed for the material in Column 3 of the 172.101 Table (See Appendix A, Page 32).
 - c. The Hazard Class or Division prescribed for the material shown in Column 4 of the 172.101 Table.
 - d. The basic description for Items a, b, and c above must be shown in sequence.
 - e. The total quantity (e.g., “800 lbs.”, “55 gal.”, “3629 kg”, or “208 L”).
 - f. “RQ” (Reportable Quantity) shall be entered before or after the basic description.
 - g. The name of the radionuclide(s) comprising 95% of the contents (abbreviations are authorized).
 - h. Description of physical or chemical form if not in special form.
 - i. Activity in each package in terms of the appropriate SI units (e.g. Becquerel) or in terms of the appropriate SI units followed by the customary units (e.g. Curies).
 - j. The category label affixed to the package (e.g. Radioactive Yellow II).
 - k. The transport index (TI) assigned to each package in the shipment bearing Radioactive Yellow II or Radioactive Yellow III labels. (NOTE: Radioactive White I transport index of 0² is not required).
 - l. Other requirements for fissile materials.
 - m. A notation of the package identification marking (e.g. Type A, Type B).
 - n. Export shipment or a shipment in a foreign made package specific requirements.
 - o. “Exclusive Use Shipment” statement for exclusive use.
 - p. Appropriate group notation for LSA-I, LSA-II, LSA-III, SCO-I or SCO-II.

- q. Other requirements for transportation by air, rail, and water.
- 2. Name of shipper.
- 3. Emergency response telephone number.
 - a. 24 hour number that is monitored at all times the hazardous material is in transit and in storage incidental to transit.
 - b. Number of a person who is knowledgeable of the shipment or has immediate access to a knowledgeable person of the shipment.
 - c. The number shall be located immediately following the description of the hazardous material or entered once on the shipping paper in a clearly visible location.
 - d. May use the number of an agency, or organization capable of and accepting responsibility, if you provide them with the current information on the material being transported.

C. Shippers Certification (172.204)

Each person who offers hazardous material for transportation shall certify that the material is properly classified, described, packaged, marked, labeled and in the proper condition for transportation according to the applicable regulations of the DOT.

- 1. The following language is approved:
 - a. “This is to clarify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation” or;
 - b. “I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.”
- 2. Exceptions
- 3. Transportation by Air

Appendix E

EMERGENCY RESPONSE INFORMATION (49 CFR 172 SUBPART G)

- A. Other than having the emergency telephone number on the shipping papers, the following emergency response information as a minimum shall be available:
1. The basic description and technical name of the hazardous material;
 2. Immediate hazards to health;
 3. Risks of fire or explosion;
 4. Immediate precautions to be taken in the event of an accident or incident;
 5. Immediate methods for handling;
 6. Initial methods for handling spills or leaks in the absence of fire; and
 7. Preliminary first aid measures.
- B. The above information must be immediately available to any person who, as a representative of a federal, State or local government agency, responds to an incident involving a hazardous material, or is conducting an investigation that involves a hazardous material.
- C. The emergency response information must be printed legibly in English.

EMERGENCY PROCEDURES (Sample)

Potential Hazards

Health Hazards

External radiation hazard from unshielded radioactive material.
Internal radiation hazard from inhalation, ingestion or breaks in skin.
Radioactive material; degree of hazards will vary greatly, depending on type and quantity of radioactive material and type of packaging.
Materials in Special Form or in Type B packaging are not expected to cause contamination in accidents.
Some radioactive materials cannot be detected by commonly available instruments.
Runoff from fire control or dilution water may cause pollution.

Fire or Explosion

Some of these materials may burn, but none of them ignites readily.
Radioactivity does not change flammability or other properties of the materials.

Emergency Action

Keep unnecessary people clear and upwind of spill; greater distances may be necessary for people downwind, or if advised by Radiation Authority.
Isolate hazard area and deny entry.
Response actions may be performed prior to any measurement of radiation; limit entry to shortest possible time.

Positive pressure self-contained breathing apparatus (SCBA) and structural firefighters' protective clothing will provide limited protection.

Notify Radiation Authority of accident conditions.

Detain uninjured persons, isolate equipment with suspected contamination, and delay cleanup until instruction of Radiation Authority.

Call James A. Smith, Radiation Safety Officer (800)555-1111 or (312)555-8888 or John A. Brown at (800) 555-1111 or (815) 555-4444.

If water pollution occurs, notify the appropriate authorities.

Fire

Do not move damaged containers; move undamaged containers out of the fire zone.

Small Fires: Dry chemical, CO₂, water spray or regular foam.

Large Fires: Water spray, fog (flooding amounts).

For massive fire in cargo area, use unmanned hose holder or monitor nozzles.

Spill or Leak

Do not touch damaged containers or spilled material.

Damage to outer container may not affect primary inner container.

Small Liquid Spills: Take up with sand, earth or other noncombustible absorbent material.

Large Liquid Spills: Dike far ahead to collect runoff water.

First Aid

Use first aid treatment according to nature of the injury.

If not affecting injury, remove and isolate suspected contaminated clothing and shoes; wrap victim in sheet or blanket before transporting.

If there is no injury, remove and isolate suspected contaminated clothing and shoes; assist person to shower with soap and water and notify Radiation Authority of action.

Advise medical personnel that victim may be contaminated with radioactive material.

In the event an accident would occur involving radioactive material during transport, the following procedure shall be followed:

1. Immediately clear the area of individuals to avoid contamination and maintain surveillance of the area.
2. Notify the Radiation Safety Officer (James A. Smith) at the following numbers:

Work (800) 555-1111
Home (312) 555-8888
3. If not available, notify John A. Brown at the following numbers:

Work (800) 555-1111
Home (815) 555-4444
4. Notify other authorities as needed. Radiation Safety Officer or John Brown will contact the IDNS (or other appropriate agency), as needed.
5. Maintain surveillance of the area until assistance arrives and the area is cleaned.
6. A copy of this procedure must be maintained in the vehicle during transport of radioactive material.

Appendix F

Miscellaneous Supplemental Information

STOWAGE LIMITS, BLOCKING, BRACING, AND SECURITY

A. Stowage Limits

1. Do not place packages with a total transport index greater than 50 in a single transport vehicle or storage location.
2. Ensure that “Radioactive Yellow” labeled packages are not placed in a transport vehicle, storage location, or in any other location closer than the distances shown in the Table in 49 CFR 177.842 where any passenger, employee, or animal may occupy. Also, maintain distance in Table for undeveloped film.
3. Observe the prohibitions on loading, transporting or stowing different kinds of hazardous materials together.
4. Observe the loading, transporting or stowing requirements for Class 7 Radioactive Material by rail (49 CFR 174), aircraft (49 CFR 175) and vessel (49 CFR 176).
5. The total transport index for packages containing fissile material may not exceed 100. Also, in loading and storage areas, each fissile material, controlled shipment must be segregated by a distance of at least six (6) meters (20 feet) from any other package bearing a radioactive DOT label.

B. Blocking, Bracing and Security

1. Any tank, barrel, drum, cylinder, or other packaging, not permanently attached to a motor vehicle which contains Class 7 (radioactive) material must be secured against movement within the vehicle.
2. Shipments of low specific activity materials and surface contaminated objects, must be loaded to avoid spillage and scattering of loose materials.
3. Packages must be blocked and braced so they cannot change position.
4. Persons should not remain unnecessarily in a vehicle containing Class 7 (radioactive) materials.
5. The dose rate may not exceed 0.02 mSv/hr (2 mR/hr) in any position normally occupied in the motor vehicle transporting a shipment under exclusive use conditions.

PACKAGE RADIATION LEVELS AND CONTAMINATION CONTROL (49 CFR 173)

A. Package Radiation Levels

1. The radiation level shall not exceed 200 mR/hr at any point on the external surface of the package and the transport index shall not exceed 10 except as described in Number 2.
2. If a package exceeds the radiation limits in Number 1, the package must be transported by exclusive use shipment only and must meet the following:
 - a. The limit is 1000 mR/hr (10 mSv/hr) as long as the following conditions are met:
 - 1) Shipment is made in a closed transport vehicle;
 - 2) Package is secured (fixed in position) within the vehicle;
 - 3) No loading or unloading of package from beginning to end of transportation.
 - b. The exposure rate at any point on the outer surface of the vehicle is not more than 200 mR/hr (2 mSv/hr);
 - c. The exposure rate at any point 2 meters (6.6 feet) from the outer lateral surfaces of the vehicle is not more than 10 mR/hr (0.1 mSv/hr);
 - d. The exposure rate in any normally occupied space does not exceed 2 mR/hr (0.02 mSv/hr) unless private carrier is monitored.
 - e. Specific written instructions are provided for maintenance of the exclusive use shipment controls to the carrier.

B. Contamination Control

1. Non-fixed (removable) radioactive contamination on the external surfaces of each package shall be kept as low as practicable;
2. Contamination may be determined by wiping an area of 300 cm² of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material.
3. Sufficient measurements shall be taken.
4. The amount of radioactivity measured on any single wiping material when averaged over the surface wiped shall not exceed the limits in the following table at any time during transport:

Removable External Radioactive Contamination Wipe Limits

<u>Contaminant</u>	Maximum Permissible Limits	
	<u>uCi/cm²</u>	<u>dpm/cm²</u>
Beta-gamma emitting radionuclides; all radionuclides with half-lives less than 10 days; natural uranium; natural thorium; U-235; U-238; Th-232, Th-238 and Th-230 when contained in ores or physical concentrates.	10 ⁻⁵	22
All other alpha emitting radionuclides.	10 ⁻⁶	2.2

5. No shipment may exceed ten times the limits listed above. (See 49 CFR 173.443 for exceptions for exclusive use shipments.)

RADIATION PROTECTION PROGRAM (49 CFR SUBPART I)

- A. Each person who offers for transportation, accepts for transportation, or transports Class 7 (radioactive) materials must develop, implement and maintain a written radiation protection program. The radiation protection program must:
1. Maintain radiation exposures ALARA with economic and social factors being taken into account;
 2. Control radiation exposures such that:
 - a. Hazmat employee's annual occupational effective dose equivalent does not exceed 12.5 mSv (1.25 Rem) in any 3 month period or 50 mSv (5 Rem) in any 12 month period. Under the age of 18 years old the limits are 1/10 of the adult limit;
 - b. Radiation exposures to members of the general public are less than 0.02 mSv (2 mRem) per hour. If an occurrence causes the dose to equal or exceed 2 mRem in one hour, the program limits will prevent an individual from receiving cumulative doses totaling 1.0 mSv (100 mRem) in any week or 5.0 mSv (500 mRem) in any 12 month period;
 - c. Embryo-fetus in a pregnant female occupationally exposed hazmat employee, who has declared pregnancy to her employer must not exceed 5.0 mSv (500 mRem) during the pregnancy;
 - d. The radiation doses received by occupationally exposed hazmat employees must be monitored by radiation dosimetry devices.
 3. The Radiation Protection Program requirements do not apply to:
 - a. Persons who offer for transportation or transport less than 200 TI of packages in a 12 month period; or
 - b. Persons whose operations will not result in a hazmat employee receiving an exposure of 5.0 mSv (500 mRem) or more per year.
 4. If an appropriate federal or state agency has approved a Radiation Protection Program, the DOT program requirement is satisfied.

5. For guidance in establishing and maintaining a program review the following:
 - a. NCRP Report No. 59 "*Operational Radiation Protection Program (1978)*" and
 - b. NCRP Report No. 116 "*Limitation of exposure to Ionizing Radiation (1993)*."
6. Record Requirements of Hazmat Employer
 - a. Document their radiation protection program and maintain written records of activities, including dosimetry records. Provide in written form within seven days of a written request.
 - b. Keep a record of the radiation dose to each hazmat employee. Provide exposure data to employee, if requested and provide exposure data no more than three months after end of employment.
 - c. Notify the Associate Administrator for Hazardous Materials Safety, in writing, if a hazmat employee receives a dose exceeding 12.5 mSv (1250 mRem) in any calendar quarter or 50 mSv (5000 mRem) in one year, or if a member of the general public is likely to receive a dose exceeding 5 mSv (500 mRem) in one year as a result of the hazmat employer's transportation activities. Notification shall be made as soon as practicable.
 - d. If not required to maintain a Radiation Protection Program, a HAZMAT employer must develop and keep records that demonstrate why a program is not required.

Appendix G

SEPARATION DISTANCES FOR MODES OTHER THAN HIGHWAY

Separation Distances: Aircraft

- 175.701(a) (a) No person may carry in a passenger-carrying aircraft any package required to be labeled RADIOACTIVE YELLOW-II or RADIOACTIVE YELLOW-III unless the package is placed in the aircraft in accordance with the minimum separation distances prescribed in paragraph (b) or (c) below.
- (b) Separation distances:
- 173.701(b) (1) Except as provided in paragraph (c) of this section, the minimum separation distances prescribed in paragraphs (b)(2) and (b)(3) of this section are determined by measuring the shortest distance between the surfaces of the Class 7 materials package and the surfaces bounding the space occupied by passengers or animals. If more than one package of Class 7 materials is placed in a passenger-carrying aircraft, the minimum separation distance for these packages must be determined in accordance with paragraphs (b)(2) and (b)(3) of this section on the basis of the sum of the transport index numbers of the individual packages or overpacks.
- 173.701(b) (2) The table below prescribes minimum separation distances that must be maintained in passenger-carrying aircraft between Class 7 materials labeled RADIOACTIVE YELLOW-II or RADIOACTIVE YELLOW-III and passengers and crew.
- (3) Class 7 materials in packages, overpacks or freight containers labeled RADIOACTIVE YELLOW-II or RADIOACTIVE YELLOW-III must be separated from live animals by a distance of at least 0.5 meters (20 inches) for journeys not exceeding 24 hours, and by a distance of at least 1.0 meters (39 inches) for journeys longer than 24 hours.

Transport index or sum of transport indexes of all packages in the aircraft or predesignated area	Minimum separation distances	
	Centimeters	Inches
0.1 – 1.0	30	12
1.1 – 2.0	50	20
2.1 – 3.0	70	28
3.1 – 4.0	85	34
4.1 – 5.0	100	40
5.1 – 6.0	115	46
6.1 – 7.0	130	52
7.1 – 8.0	145	57
8.1 – 9.0	155	61
9.1 – 10.0	165	65
10.1 – 11.0	175	69
11.1 – 12.0	185	73
12.1 – 13.0	195	77
13.1 – 14.0	205	81
14.1 – 15.0	215	85
15.1 – 16.0	225	89
16.1 – 17.0	235	93
17.1 – 18.0	245	97
18.1 – 20.0	260	102
20.1 – 25.0	290	114
25.1 – 30.0	320	126
30.1 – 35.0	350	138
35.1 – 40.0	375	148
40.1 – 45.0	400	157
45.1 – 50.0	425	167

- 173.701 (c) (c) Predesignated areas. A package required to be labeled RADIOACTIVE YELLOW-II or RADIOACTIVE YELLOW-III may be carried in a passenger-carrying aircraft in accordance with a system of predesignated areas established by the aircraft operator. Each aircraft operator that elects to use a system of predesignated areas must submit a detailed description of the proposed system to the Associate Administrator for Hazardous Materials Safety for approval prior to implementation of the system. A proposed system of predesignated areas is approved if the Associate Administrator for Hazardous Materials Safety determines that it is designed to assure that:
- (1) The packages can be placed in each predesignated area in accordance with the minimum separation distances prescribed in paragraph (b)(2) of this section; and
 - (2) The predesignated areas are separated from each other by a minimum distance equal to at least four times the distances required by paragraph (b)(1) and (b)(2) of this section for the predesignated area containing packages with the largest sum of transport indices.

Separation Distances: Railroad

- 174.701(c) (a) Each package of Class 7 materials bearing RADIOACTIVE YELLOW-II or RADIOACTIVE YELLOW-III labels may not be placed closer than 0.9 meter (3 feet) to an area (or dividing partition between areas) which may be continuously occupied by any passenger, rail employee, or shipment of one or more animals, nor closer than 4.5 meters (15 feet) to any package containing undeveloped film (if so marked). If more than one package of Class 7 materials is present, the distance must be computed from the table below on the basis of the total transport index number (determined by adding together the transport index numbers on the labels of the individual packers) of packages in the rail car or storage area.

Total Transport Index	Minimum separation distance to nearest undeveloped film		Minimum distance to area of persons or minimum distance from dividing partition of a combination car	
	Meters	Feet	Meters	Feet
None	0	0	0	0
0.1 to 10.0	4.5	15	0.9	3
10.1 to 20.0	6.7	22	1.2	4
20.1 to 30.0	7.7	29	1.5	5
30.1 to 40.0	10.0	33	1.8	6
40.1 to 50.0	10.9	36	2.1	7

Note: The distance in this table must be measured from the nearest point on the nearest packages of Class 7 materials.

- 176.708(a) (a) The table below provides the segregation distances which apply to the stowage of packages of Class 7 materials on board a vessel.
- (b) RADIOACTIVE YELLOW-II or YELLOW-III labeled packages may not stowed any closer to living accommodations, regularly occupied working spaces, spaces that may be continually occupied by any person (except those spaces exclusively reserved for couriers specifically authorized to accompany such packages), or undeveloped film than the distances specified in the table below.

Sum of transport indexes of the packages	Minimum distance in feet from living quarters or regularly occupied working space	Minimum distance in feet from undeveloped film and plates																				
		1 day voyage		2 day voyage		4 day voyage		10 day voyage		20 day voyage		30 day voyage		40 day voyage		50 day voyage						
		Cargo thickness in feet (unit density)																				
Nil	3	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	
0.1 to 0.5	5	X	X	X	8	X	X	X	17	4	X	25	6	X	30	7	X	35	8	X	39	9
0.1 to 0.5	6	X	X	X	11	X	X	X	25	6	X	35	8	X	42	10	X	50	12	X	55	13
1.1 to 2	9	X	X	X	16	X	X	X	35	8	X	50	12	X	61	14	X	70	17	X	78	19
2.1 to 3	10	X	X	X	19	5	X	27	6	X	42	10	X	61	14	X	74	18	X	86	20	
3.1 to 5	13	X	X	X	25	6	X	35	8	X	55	13	X	78	19	X	96	23	X	110	26	
5.1 to 10	19	X	X	X	35	8	X	50	12	X	78	19	X	110	26	X	135	33	8	155	37	
10.1 to 20	26	6	35	8	X	50	12	X	69	17	X	110	26	X	155	37	9	190	46	11	220	
20.1 to 30	32	8	43	10	X	61	14	X	85	20	X	135	32	8	190	45	11	235	56	13	270	
30.1 to 50	42	10	55	13	X	78	19	X	110	26	X	175	42	10	245	58	14	300	73	17	350	
50.1 to 100	59	14	78	19	X	110	26	X	155	37	9	245	59	14	350	82	20	435	105	24	515	
100.1 to 150	72	17	96	23	X	135	32	8	190	46	11	300	72	17	425	100	24	525	125	30	600	
150.1 to 200	84	20	110	26	9	155	37	9	200	53	13	350	84	20	490	115	28	600	140	35	715	
200.1 to 300	105	24	135	32	X	190	46	11	270	64	15	425	105	25	600	145	35	750	180	42	900	
300.1 to 400	120	28	160	37	9	220	53	13	310	75	18	500	120	28	675	165	40	825	205	49	1012	
400.1 to 500	135	32	195	45	13	270	64	15	425	105	25	600	145	35	750	180	42	900	230	55	1230	
500.1 to 600	150	36	225	54	16	315	77	19	570	144	18	675	165	40	825	205	49	1012	265	63	1455	
600.1 to 700	165	40	255	60	18	360	90	21	720	180	21	765	191	48	945	236	53	1125	295	68	1680	
700.1 to 800	180	44	290	66	20	405	100	23	810	200	24	855	211	52	1035	261	58	1260	325	73	1920	
800.1 to 900	195	48	325	72	22	450	110	25	900	220	26	945	236	58	1180	296	63	1400	360	80	2160	
900.1 to 1000	210	52	360	78	24	495	120	27	990	240	28	1035	261	65	1260	325	70	1540	395	88	2400	
1000.1 to 1100	225	56	395	84	26	540	132	29	1080	264	30	1125	280	72	1350	340	80	1680	430	96	2700	
1100.1 to 1200	240	60	430	90	28	585	144	31	1170	288	32	1215	304	75	1485	370	84	1820	465	104	3000	
1200.1 to 1300	255	64	465	96	30	630	156	33	1260	312	34	1305	328	78	1590	400	88	2016	504	112	3360	
1300.1 to 1400	270	68	495	100	32	675	168	35	1350	336	36	1400	352	80	1710	420	96	2160	540	120	3600	
1400.1 to 1500	285	72	525	108	34	720	180	36	1440	360	38	1500	384	84	1800	440	100	2250	576	128	3840	
1500.1 to 1600	300	76	555	112	36	765	192	38	1530	372	40	1600	400	88	1920	460	104	2340	600	136	4080	
1600.1 to 1700	315	80	585	116	38	810	204	40	1620	384	42	1700	420	92	2040	480	108	2430	636	144	4320	
1700.1 to 1800	330	84	615	120	40	855	216	42	1680	400	44	1800	440	96	2160	500	112	2520	672	152	4560	
1800.1 to 1900	345	88	645	124	42	900	228	44	1770	420	46	1900	460	96	2280	520	116	2610	708	160	4800	
1900.1 to 2000	360	92	675	128	44	945	240	46	1860	440	48	2000	480	100	2400	540	120	2700	744	168	5040	

NOTE:

- NOTE:
- (1) X — indicates that thickness of screening cargo is sufficient without any additional segregation distance.
 - (2) By using 6 feet of intervening unit density cargo for persons and 10 feet for film and plates, no distance shielding is necessary for any length of voyage specified.
 - (3) Using 1 steel bulkhead or steel deck — multiply segregation distance by 0.8. Using 2 steel bulkheads or steel decks — multiply segregation distance by 0.64.
 - (4) "Cargo of Unit Density" means cargo stowed at a density of 1 ton (long) per 36 cubic feet; where the density is less than this the depth of cargo specified must be increased in proportion.
 - (5) "Minimum distance" means the least in any direction whether vertical or horizontal from the outer surface of the nearest package.
 - (6) The total consignment on board at any time must not exceed transport indexes totaling 200 except if carried under the provisions of §176.704(f). The figures below the double line of the table should be used in such a contingency.
 - (7) Not to be carried unless screening by other cargo and bulkheads can be arranged in accordance with the other columns.

- 176.708(c) (c) Where only one consignment of a Class 7 material is to be loaded on board a vessel under exclusive use conditions, the appropriate segregation distance may be established by demonstrating that the direct measurement of the radiation level at regularly occupied working spaces and living quarters is less than 0.0075 mSv/h (0.75 mrem/hr).
- 176.708(d) (d) More than one consignment may be loaded on board a vessel with the appropriate segregation distance established by demonstrating that direct measurement of the radiation level at regularly occupied working spaces and living quarters is less than 0.0075 mSv/hr (0.75 mrem/hr), provided that:
- (1) The vessel has been chartered for the exclusive use of a competent person specialized in the carriage of Class 7 material, and
 - (2) Stowage arrangements have been predetermined for the entire voyage, including any Class 7 material to be loaded at ports of call en route.
- 176.708(e) (e) The radiation level must be measured by a responsible person skilled in the use of monitoring equipment.

Appendix H

PACKAGING/PACKAGE DESIGN AND TEST REQUIREMENTS										
References		Requirements	49 CFR					10 CFR		
10 CFR	49 CFR		Small Quantity	Excepted	IP Type 1	IP Type 2	IP Type 3	Type A	>Type A	Type B
		<i>General requirements for hazmat packagings and packages:</i>								
	173.24(b)(1)	Designed etc. so that under conditions normally incident to transportation:	X	X	X	X	X	X		
	173.24(b)(2)	No identifiable release	X	X	X	X	X	X		
	173.24(b)(3)	Effectiveness of packages not reduced	X	X	X	X	X	X		
	173.24(c)	No reduction in effectiveness from spontaneous pressure increase	X	X	X	X	X	X		
	173.24(d)	Packagings compatible with lading	X	X	X	X	X	X		
	173.24(e)	Closures secure, leakproof, adequate	X	X	X	X	X	X		
	173.24(f)	Venting only permitted under certain circumstances	X	X	X	X	X	X		
	173.24(g)	Ullage for liquid expansion	X	X	X	X	X	X		
	173.24(h)	Liquids packed with closures upward	X	X	X	X	X	X		
	172.312	Not overpacked with Class 8, Packing Group I, or Div. 5.1 materials	X	X	X	X	X	X		
	173.25(o)(5)	For air transport:	X	X	X	X	X	X		
	173.24(i)	Meet pressure requirements	X	X	X	X	X	X		
	173.27(c)	Closures secure	X	X	X	X	X	X		
	173.27(d)	Absorbent materials for liquids	X	X	X	X	X	X		
	173.27(e)	Valves of cylinders protected	X	X	X	X	X	X		
	173.27(f)	No tank cars or cargo tanks	X	X	X	X	X	X		
	173.27(h)		X	X	X	X	X	X		
		<i>General requirements for non-bulk hazmat packagings and packages:</i>								
	173.24(a)(1)	Closures for inner liquid packages upright	X	X	X	X	X	X		
	173.24(a)(2)	Friction not likely to generate heat	X	X	X	X	X	X		
	173.24(a)(3)	Secured and cushioned to prevent breakage, leakage, movement	X	X	X	X	X	X		
	173.24(a)(4)	No nails, staples protruding inside to damage inner packagings	X	X	X	X	X	X		
	173.24(a)(5)	Capable of withstanding vibration	X	X	X	X	X	X		

PACKAGING/PACKAGE DESIGN AND TEST REQUIREMENT S (Continued)											
References		Requirements	49 CFR						10 CFR		
10 CFR	49 CFR		Small Quantity	Excepted	IP Type 1	IP Type 2	IP Type 3	Type A	>Type A	Type B	Fissile *
71.45(a) 71.71(c)(5) 71.43(d) 71.43(e)	173.410	<i>General design requirements for Class 7 packages:</i> Easily handled and secured Lifting attachments able to cope with load Surface free from protruding features and easily decontaminated Avoidance of crevices where water can collect Added features will not reduce safety Capable of withstanding normal vibration, acceleration Physically and chemically compatible construction materials Any valves protected against unauthorized operation For air transport: Maximum surface temperature of 50 °C Capable of withstanding maximum and minimum temperatures For liquids, no leakage with pressure differential ≥ 95kPa	X	X	X	X	X	X			
	173.410(a)		X	X	X	X	X	X	X		
	173.410(b)		X	X	X	X	X	X	X	X	
	173.410(c)		X	X	X	X	X	X	X	X	X
	173.410(d)		X	X	X	X	X	X	X		
	173.410(e)		X	X	X	X	X	X	X		
	173.410(f)		X	X	X	X	X	X	X		
	173.410(g)		X	X	X	X	X	X	X	X	X
	173.410(h)		X	X	X	X	X	X	X	X	X
	173.410(i)		X	X	X	X	X	X	X	X	X
71.43(e)	173.410(i)(1)	<i>Small quantity exception requirements:</i> Except for temperature sensing devices, each inner receptacle: Must not be liquid-full at 55 °C Made of plastic ≥ 0.2 mm, or earthenware, glass or metal Inner receptacle with a removable closure must have closure secured Inner receptacle securely packed with cushioning/absorbent material that: Does not react chemically with material Absorbs entire contents if liquid Inside packaging securely packed in a strong outside packaging Pass drop tests from 1.8 m Pass compressive test of 3 m stack of identical packages for 24 h Gross mass not exceed 29 kg	X	X							
	173.410(i)(2)		X	X	X	X	X	X			
	173.410(i)(3)		X	X	X	X	X	X			
	173.4										
	173.4(2)(i)		X								
	173.4(2)(ii)		X								
	173.4(3)		X								
	173.4(4)(i)		X								
	173.4(4)(ii)		X								
	173.4(5)		X								
71.43(e)	173.4(6)(i)	X									
	173.4(6)(ii)	X									
	178.606(c)	X									
	173.4(8)	X									

PACKAGING/PACKAGE DESIGN AND TEST REQUIREMENT S (Continued)											
References		Requirements	49 CFR					10 CFR			
10 CFR	49 CFR		Small Quantity	Excepted	IP Type 1	IP Type 2	IP Type 3	Type A	>Type A	Type B	Fissile *
71.43, 71.45	173.412	<i>Additional design requirements for Type A packages/general standards:</i>									
71.43(b)	173.412(a)	Incorporate a seal to indicate if package opened						X	X	X	X
71.43(a)	173.412(b)	Smallest external dimension of 10 cm						X	X	X	X
	173.412(c)	Containment and shielding maintained over temp. range -40 °C to 70 °C						X	X	X	X
71.43(c)	173.412(d)	Containment with positive closing device that cannot be opened unintentionally or by pressure during transport						X	X	X	X
	173.412(e)	Radiolytic decomposition and gas generation taken into account						X	X	X	X
71.71(c)(3)	173.412(f)	Retain contents under pressure reduction to 25 kPa						X	X	X	X
71.71(c)(4)		Withstand pressure increase of 140 kPa absolute						X	X	X	X
71.43(e)	173.412(g)	Enclosure for valves to retain any leakage, except relief valves						X	X	X	X
	173.412(h)	Radiation shield enclosing a containment component will prevent escape of component from shield						X	X	X	X
71.45(b)(1,2)		Any tie-downs must meet strength requirements						X	X	X	X
71.45(b)(3)	173.412(i)	Failure of tie down must not impair package meeting requirements						X	X	X	X
71.43(f)	173.412(j)	Pass normal conditions of transport tests:									
71.51(a)(1)		Water spray test - 5 cm/h for 1 h									
71.71(c)(6)	173.465(b)	Free drop test - height depends on package mass						X	X	X	X
71.71(c)(7)	173.465(c)(1)	Additional corner drop test			X			X	X	(mass)	X
71.71(c)(8)	173.465(2-4)	Stacking test/compression test			X			board	/wood	X	X
71.71(c)(9)	173.465(d)	Penetration test from 1 m			X			X	X	X	X
71.71(c)(10)	173.465(e)	Ambient temperature of 38 °C						X	X	X	X
71.71(c)(1)		Ambient temperature of -40 °C						X	X	X	X
71.71(c)(2)		For liquids:									
	173.412(k)	Allow for ullage									
	173.412(k)(1)	Have absorbent material for 2 times the liquid volume						X	X	X	X
	173.412(k)(3)	or Have primary inner & sec. outer container to assure liquid retention						X	X	X	X
	173.412(k)(3)	For liquids and gases (except ≤ 40 TBq ³ H or ≤ A ₂ noble gases)						X	X	X	X
	173.412(l)	Pass free drop test from 9 m						X	X	X	X
	173.466(a)(1)	Pass free drop test from 1.7 m						X	X	X	X
	173.466(a)(2)	Pass penetration test from 1.7 m						X	X	X	X

PACKAGING/PACKAGE DESIGN AND TEST REQUIREMENT S (Continued)											
References		Requirements	49 CFR					10 CFR			Fissile *
10 CFR	49 CFR		Small Quantity	Excepted	IP Type 1	IP Type 2	IP Type 3	Type A	>Type A	Type B	
71.43(g)	173.442(a) 173.442(b) 173.442(b)(1) 173.442(b)(2)	Heat generated by contents will not affect package integrity Maximum package surface temperature in still air at 38 °C 50 °C for non-exclusive use shipment 85 °C for exclusive use shipment May not incorporate a feature to allow continuous venting during transport	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X
71.43(h)											
71.51		<i>Additional requirements for Type B packages:</i>									
71.51(a)(2)		Pass accident conditions of transport tests (w/o filters or cooling systems)									
71.73(c)(1)		Free drop test - 9 m								X	X
71.73(c)(2)		Crush test for light/low density/ ≥ 1000 A ; packages only								X	X
71.73(c)(3)		Puncture test - 1 m onto 15 cm diameter bar								X	X
71.73(c)(4)		Thermal test - 800 °C for 30 minutes								X	X
71.73(c)(5)		Immersion - for some fissile packages 0.9 m								X	X
71.73(c)(6)		Immersion - 15 m, 150 kPa (separate specimen)								X	X
71.55		<i>General requirements for fissile packages:</i>									
71.55(b)(c)		Remain subcritical under a variety of circumstances including:									
71.55(d)		Water leakage, liquid contents leaking out (or be excepted to this)									X
71.55(e)		Normal conditions of transport tests									X
71.59(a)		Accident conditions of transport tests									X
		Value of N derived, and a T1 for criticality control assigned									X
		<i>Special requirement for irradiated nuclear fuel shipments:</i>									
71.61		Containment system withstand 2 MPa for ≥ 1 h w/o buckling or leakage								>37 PBq	>37 PBq

Table I

ACTIVITY LIMITS FOR EXCEPTED PACKAGES

Nature of contents	Instruments and articles		Materials package limits ¹
	Limits for each instrument or article ¹	Package Limits ¹	
Solids:			
Special form	$10^{-2} A_1$	A_1	$10^{-3} A_1$
Normal form	$10^{-2} A_2$	A_2	$10^{-3} A_2$
Liquids:			
Tritiated water:			
<0.0037 TBq/liter (0.1 Ci/L)			37 TBq (1,000 Ci)
0.0037 TBq to 0.037 TBq/L (0.1 Ci to 1.0 Ci/L)			3.7 TBq (100 Ci)
<0.037 TBq/L (1.0 Ci/L)			0.037 TBq (1.0 Ci)
Other Liquids	$10^{-3} A_2$	$10^{-1} A_2$	$10^{-4} A_2$
Gases:			
Tritium ²	$2 \times 10^{-2} A_2$	$2 \times 10^{-1} A_2$	$2 \times 10^{-2} A_2$
Special form	$10^{-3} A_1$	$10^{-2} A_1$	$10^{-3} A_1$
Other form	$10^{-3} A_2$	$10^{-2} A_2$	$10^{-3} A_2$

¹ For mixtures of radionuclides see §173.433(d).

² These values also apply to tritium in activated luminous paint and tritium absorbed on solid carriers.

Excepted packages must meet the following:

1. The general design requirements cited in paragraph B above;
2. Non-fixed contamination limits on package surfaces must not exceed the limits of §173.443(a);
3. The radiation level at any point on the surface of the package must not exceed 0.005 mSv/hour (0.5 mrem/hour);
4. The outside of the inner packaging, or if there is no inner packaging, the outside of the package itself must bear the marking "RADIOACTIVE", except for instruments or article, or empty packaging;
5. For instruments or articles, the radiation level at four inches from any point on the surface of the unpackaged instrument or article may not exceed 0.1 mSv/hour (10 mrem/hour);
6. In lieu of a specific shipping paper, a prescribed certification statement referencing the applicable exception paragraph must be included "in", "on", or "with" the package.

The specific sections of 49 CFR for the various categories of excepted radioactive packages include:

- §173.421 Excepted packages for limited quantities of Class 7 radioactive material
- §173.422 Additional requirements for excepted packages containing Class 7 radioactive material
- §173.423 Requirements for multiple hazard limited quantity Class 7 radioactive material
- §173.424 Excepted packages for radioactive instruments and articles
- §173.426 Excepted packages for articles containing natural uranium or thorium
- §173.428 Empty Class 7 radioactive material packaging

Table II
49 CFR 172.101 TABLE II - RADIONUCLIDES (EXCERPTS)

Radionuclide	Atomic Number	Reportable Quantity (RQ) Ci (TBq)
Americium-241	95	0.01 (.00037)
Barium-133	56	10 (.37)
Bismuth-210	83	10 (.37)
Cadmium-109	48	1 (.037)
Calcium-45	20	10 (.37)
Californium-252	98	0.1 (.0037)
Carbon-14	6	10 (.37)
Cesium-137	55	1 (.037)
Chromium-51	24	1000 (37)
Cobalt-57	27	100 (3.7)
Cobalt-60	27	10 (.37)
Fluorine-18	9	1000 (37)
Gadolinium-153	64	10 (.37)
Gallium-67	31	100 (3.7)
Gold-195	79	100 (3.7)
Indium-111	49	100 (3.7)
Iodine-123	53	10 (.37)
Iodine-125	53	0.01 (.00037)
Iodine-129	53	0.001 (.000037)
Iodine-131	53	0.01 (.00037)
Iridium-192	77	10 (.37)
Iron-59	26	10 (.37)
Krypton-85	36	1000 (37)
Lead-210	82	0.01 (.00037)
Molybdenum-99	42	100 (3.7)
Nickel-63	28	100 (3.7)
Palladium-103	46	100 (3.7)
Phosphorus-32	15	0.1 (.0037)
Phosphorus-33	15	1 (.037)
Plutonium-239	94	0.01 (.00037)
Potassium-40	19	1 (.037)
Promethium-147	61	10 (.37)
Radium-226**	88	0.1 (.0037)
Radon-222	86	0.1(.0037)
Samarium-153	62	100 (3.7)
Sodium-22	11	10 (.37)
Strontium-89	38	10 (.37)
Strontium-90	38	0.1 (0037)
Sulfur-35	16	1 (.037)
Technetium-99	43	10 (.37)
Technetium-99m	43	100 (3.7)
Thallium-201	81	1000 (37)
Thallium-204	81	10 (.37)
Thorium (Irradiated)	90	***
Thorium (Natural)	90	**

49 CFR 172.101 TABLE II - RADIONUCLIDES (EXCERPTS)

Radionuclide	Atomic Number	Reportable Quantity (RQ) Ci (TBq)
Thorium-230	90	0.01 (.00037)
Thorium-232**	90	0.001 (.000037)
Thorium-234	90	100 (3.7)
Uranium (Depleted)	92	***
Uranium (Irradiated)	92	***
Uranium (Natural)	92	**
Uranium Enriched 20% or greater	92	***
Uranium Enriched less than 20%	92	***
Uranium-235**	92	0.1 (.0037)
Uranium-238**	92	0.1 (.0037)
Xenon-133	54	1000 (37)
Yttrium-90	39	10 (.37)

The RQs for all radionuclides apply to chemical compounds containing the radionuclides and elemental forms regardless of the diameter of pieces of solid material.

E+ The RQ of one curie applies to all radionuclides not otherwise listed. Whenever the RQs in TABLE 1-HAZARDOUS SUBSTANCES OTHER THAN RADIONUCLIDES and this table conflict, the lowest RQ shall apply. For example, uranyl acetate and uranyl nitrate have RQs shown in TABLE 1 of 100 pounds, equivalent to about one-tenth the RQ level for uranium-238 in this table.

** The method to determine the RQs for mixtures or solutions of radionuclides can be found in paragraph 6 of the note preceding TABLE 1 of this appendix. RQs for the following four common radionuclide mixtures are provided: Radium-226 in secular equilibrium with its daughters (0.053 curie); natural uranium (0.1 curie); natural uranium in secular equilibrium with its daughters (0.052 curie); and natural thorium in secular equilibrium with its daughters (0.011 curie).

*** Indicates that the name was added by RSPA because it appears in the list of radionuclides in 49 CFR 173.435. The reportable quantity (RQ), if not specifically listed elsewhere in this appendix, shall be determined in accordance with the procedures in paragraph 6 of this appendix.

TABLE III
Proper Shipping Names and UN Numbers
49 CFR 172.101
(Updated 10/1/2006)

Pipeline and Hazardous Materials Safety Admin., DOT

§ 172.101

Pyroxylin, solution or solvent, see Nitrocellulose.	3	UN1922	II	3, 8	IB2, T7, TP1	150	202	243	1 L	5 L	B	40
Pyrolydine	Forbidden											
Quebrachital pentanitrate												
Quicklime, see Calcium oxide												
Quinoline	6.1	UN2656	III	6.1	IB3, T4, TP1	153	203	241	60 L	220 L	A	12
R 12, see Dichlorodifluoromethane.												
R 12B1, see												
R Chlorodifluorobromomethane.												
R 13, see												
R Chlorotrifluoromethane.												
R 13B1, see												
R Bromotrifluoromethane.												
R 14, see Tetrafluoromethane												
R 21, see												
R Dichlorodifluoromethane.												
R 22, see												
R Chlorodifluoromethane.												
R 114, see												
R Dichlorotetrafluoroethane.												
R 115, see												
R Chloropentafluoroethane.												
R 116, see Hexafluoroethane												
R 124, see												
R Chlorotetrafluoroethane.												
R 133a, see												
R Chlorotrifluoroethane.												
R 152a, see Difluoroethane												
R 500, see Dichlorodifluoromethane and difluoroethane, etc.												
R 502, see												
R Chlorodifluoromethane and chloropentafluoroethane mixture, etc.												
R 503, see												
R Chlorotrifluoromethane and trifluoroethane, etc.												
Radioactive material, excepted package-articles manufactured from natural uranium or depleted uranium or natural thorium.	7	UN2909		None		422, 426.	422, 426.	422, 426.			A	
Radioactive material, excepted package-empty packaging.	7	UN2908		Empty		422, 428.	422, 428.	422, 428.			A	
Radioactive material, excepted package-instruments or articles.	7	UN2911		None		422, 424.	422, 424.	422, 424.			A	

§ 172.101 HAZARDOUS MATERIALS TABLE—Continued

(1) Sym- bols	(2) Hazardous materials descrip- tions and proper shipping names	(3) Hazard class or Di- vision	(4) Identifica- tion Num- bers	(5) PG	(6) Label Codes	(7) Special provi- sions (§ 172.102)	(8) Packaging (§ 173.***)			(9) Quantity limitations (see §§ 173.27 and 175.75)		(10) Vessel stow- age	
							Excep- tions	Non- bulk	Bulk	Passenger aircraft/rail	Cargo air- craft only	Loca- tion	Other
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8A)	(8B)	(8C)	(9A)	(9B)	(10A)	(10B)
	Radioactive material, excepted package-limited quantity of material.	7	UN2910	.....	None		421, 422.	421, 422.	421, 422.	.....	.....	A	.....
	Radioactive material, low spe- cific activity (LSA-I) <i>non fissile</i> or <i>fissile-excepted</i> .	7	UN2912	.....	7	A56, T5, TP4, W7	421, 422, 428.	427	427	.....	.....	A	95, 129
	Radioactive material, low spe- cific activity (LSA-II) <i>non</i> <i>fissile</i> or <i>fissile-excepted</i> .	7	UN3321	.....	7	A56, T5, TP4, W7	421, 422, 428.	427	427	.....	.....	A	95, 129
	Radioactive material, low spe- cific activity (LSA-III) <i>non</i> <i>fissile</i> or <i>fissile-excepted</i> .	7	UN3322	.....	7	A56, T5, TP4, W7	421, 422, 428.	427	427	.....	.....	A	95, 129
	Radioactive material, surface contaminated objects (SCO-I or SCO-II) <i>non fissile</i> or <i>fissile-excepted</i> .	7	UN2913	.....	7	A56	421, 422, 428.	427	427	.....	.....	A	95
	Radioactive material, trans- ported under special arrange- ment, <i>non fissile</i> or <i>fissile ex-</i> <i>cepted</i> .	7	UN2919	.....	7	A56, 139	.....	.....	.....	.....	.....	A	95, 105
	Radioactive material, trans- ported under special arrange- ment, <i>fissile</i> .	7	UN3331	.....	7	A56, 139	.....	.....	.....	.....	.....	A	95, 105
	Radioactive material, Type A package, <i>fissile non-special</i> <i>form</i> .	7	UN3327	.....	7	A56, W7, W8	453	417	417	.....	.....	A	95, 105, 131 95, 130
	Radioactive material, Type A package <i>non-special form</i> , <i>non fissile</i> or <i>fissile-excepted</i> .	7	UN2915	.....	7	A56, W7, W8	.....	415, 418.	415, 419.	.....	.....	A	95
	Radioactive material, Type A package, special form <i>non</i> <i>fissile</i> or <i>fissile-excepted</i> .	7	UN3332	.....	7	A56, W7, W8	.....	415, 476.	415, 476.	.....	.....	A	95
	Radioactive material, Type A package, special form, <i>fissile</i> .	7	UN3333	.....	7	A56, W7, W8	453	417, 476.	417, 476.	.....	.....	A	95, 105
	Radioactive material, Type B(M) package, <i>fissile</i> .	7	UN3329	.....	7	A56	453	417	417	.....	.....	A	95, 105

Radioactive material, Type B(M) package <i>non fissile or fissile-excepted</i> .	7	UN2917	.....	7	.....	A56	.....	416	.....	416	.....	.....	.....	A	.....	95, 105
Radioactive material, Type B(U) package, fissile.	7	UN3328	.....	7	.....	A56	453	417	.....	417	.....	.....	.....	A	.....	95, 105
Radioactive material, Type B(U) package <i>non fissile or fissile-excepted</i> .	7	UN2916	.....	7	.....	A56	.....	416	.....	416	.....	.....	.....	A	.....	95, 105
Radioactive material, uranium hexafluoride <i>non fissile or fissile-excepted</i> .	7	UN2978	.....	7, 8	.....		423	420, 427.	.....	420, 427.	.....	.....	.....	A	.....	95, 132
Radioactive material, uranium hexafluoride, fissile.	7	UN2977	.....	7, 8	.....		453	417, 420.	.....	417, 420.	.....	.....	.....	A	.....	95, 132
Rags, oily	4.2	UN1856	III	4.2	.....		151	213	.....	240	.....	Forbidden	Forbidden	A	.....	.....
Railway torpedo, see Signals, railway track, explosive.																
Rare gases and nitrogen mixtures, compressed.	2.2	UN1981	.....	2.2	.....		306	302	.....	None	.....	75 kg	150 kg	A	.....	.....
Rare gases and oxygen mixtures, compressed.	2.2	UN1980	.....	2.2	.....		306	302	.....	None	.....	75 kg	150 kg	A	.....	.....
Rare gases mixtures, compressed.	2.2	UN1979	.....	2.2	.....		306	302	.....	None	.....	75 kg	150 kg	A	.....	.....
RC 318 see																
Octafluorocyclobutane.																
RDX and cyclotetramethylenetetranitramine, wetted or desensitized see RDX and HMX mixtures, wetted or desensitized.																
RDX and HMX mixtures, wetted with not less than 15 percent water by mass or RDX and HMX mixtures, desensitized with not less than 10 percent phlegmatizer by mass.	1.1D	UN0391	II	1.1D	.....		None	62	.....	None	.....	Forbidden	Forbidden	10	.....	.....
RDX and Octogen mixtures, wetted or desensitized see RDX and HMX mixtures, wetted or desensitized etc.																
RDX, see Cyclotrimethylene trinitramine, etc.																
Receptacles, small, containing gas (gas cartridges) non-flammable, without release device, not refillable and not exceeding 1 L capacity.	2.2	UN2037	.....	2.2, 5.1.	.....	A14	306	304	.....	None	.....	1 kg	15 kg	B	.....	40

ensure that the radioactive material is not released into the conveyance or to the environment.

(d) LSA and SCO that exceed the packaging limits in this section must be packaged in accordance with 10 CFR part 71.

(e) Tables 5 and 6 are as follows:

TABLE 5.—CONVEYANCE ACTIVITY LIMITS FOR LSA MATERIAL AND SCO

Nature of material	Activity limit for conveyances
1. LSA—I	No limit.
2. LSA—II and LSA—III; non-Combustible solids.	No limit.
3. LSA—II and LSA—III; Combustible solids and all liquids and gases.	100 A ₂
4. SCO	100 A ₂

TABLE 6.—INDUSTRIAL PACKAGE INTEGRITY REQUIREMENTS FOR LSA MATERIAL AND SCO

Contents	Industrial packaging type	
	Exclusive use shipment	Non exclusive use shipment
1. LSA—I:		
Solid	IP-1	IP-1
Liquid	IP-1	IP-2
2. LSA—II:		
Solid	IP-2	IP-2
Liquid and gas	IP-2	IP-3
3. LSA—III:		
SCO—I	IP-1	IP-1
SCO—II	IP-2	IP-2

■ 27. In § 173.428, the introductory text is revised, paragraphs (c), (d) and (e) are redesignated as paragraphs (d), (e) and (f) respectively, and a new paragraph (c) is added to read as follows:

§ 173.428 Empty Class 7 (radioactive) materials packaging.

A packaging which previously contained Class 7 (radioactive) materials and has been emptied of contents as far as practical, is excepted from the shipping paper and marking (except for the UN identification number marking requirement described in § 173.422(a)) requirements of this subchapter, provided that—

(c) The outer surface of any uranium or thorium in its structure is covered with an inactive sheath made of metal or some other substantial material;

■ 28. In § 173.431, paragraph (b) is revised to read as follows:

§ 173.431 Activity limits for Type A and Type B packages.

(b) The limits on activity contained in a Type B(U) or Type B(M) package are those prescribed in §§ 173.416 and 173.417, or in the applicable approval certificate under §§ 173.471, 173.472 or 173.473.

■ 29. Section 173.433 is revised to read as follows:

§ 173.433 Requirements for determining basic radionuclide values, and for the listing of radionuclides on shipping papers and labels.

(a) For individual radionuclides listed in the table in § 173.435 and § 173.436:

(1) A₁ and A₂ values are given in the table in § 173.435; and

(2) Activity concentration exemption values and consignment activity exemption values are given in the table in § 173.436.

(b) For individual radionuclides which are not listed in the tables in § 173.435 or § 173.436:

(1) the radionuclide values in Tables 7 or 8 of this section may be used; or

(2) other basic radionuclide values may be used provided they are first approved by the Associate Administrator or, for international transport, multilateral approval is obtained from the pertinent Competent Authorities.

(c) In calculating A₁ or A₂ values for a radionuclide not listed in the table in § 173.435:

(1) Where the chemical form of each radionuclide is known, it is permissible to use the A₂ value related to its solubility class as recommended by the International Commission on

Radiological Protection, if the chemical forms under both normal and accident conditions of transport are taken into consideration.

(2) A single radioactive decay chain in which the 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, will be considered as a single radionuclide, and the activity to be taken into account and the A₁ or A₂ value to be applied will be those corresponding to the parent nuclide of that chain. Otherwise, the parent and daughter nuclides will be considered as a mixture of different nuclides.

(d) Mixtures of radionuclides whose identities and respective activities are known must conform to the following conditions:

(1) For special form Class 7 (radioactive) material, the activity which may be transported in a Type A package must satisfy:

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

Where:

B(i) is the activity of radionuclide i in special form; and

A₁(i) is the A₁ value for radionuclide i.

(2) For normal form Class 7 (radioactive) material, the activity which may be transported in a Type A package must satisfy:

$$\sum_j \frac{C(j)}{A_2(j)} \leq 1$$

Where:

C(j) is the activity of radionuclide j in normal form; and

A₂(j) is the A₂ value for radionuclide j.

(3) If the package contains both special and normal form Class 7 (radioactive) material, the activity which may be transported in a Type A package must satisfy:

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

Where:

The symbols are defined as in paragraphs (d)(2) and (d)(3) of this section.

(4) Alternatively, the A₁ value for a mixture of special form material may be determined as follows:

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

Where:

f(i) is the fraction of activity for radionuclide i in the mixture; and

A₁(i) is the appropriate A₁ value for radionuclide i.

(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 for normal form radionuclide i in the mixture; and

A₂(i) is the appropriate A₂ value for radionuclide i.

(6) The exempt activity concentration for mixtures of nuclides 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 concentration of nuclide i in the mixture; and

$[A](i)$ is the activity concentration for exempt material containing nuclide i .

(7) The activity limit for an exempt consignment for mixtures of nuclides 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 nuclide i in the mixture; and

$A(i)$ is the activity limit for exempt consignments for nuclide i .

(e) When the identity of each nuclide 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 paragraphs (d)(1) through (d)(5) of this section. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest A_1 or A_2 values for the alpha emitters or beta/gamma emitters, respectively.

(f) When the identity of each nuclide is known but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest $[A]$ (activity concentration for exempt material) or A (activity limit for exempt consignment) value, as appropriate, for the radionuclides in each group may be used in applying the formulas in paragraphs (d)(6) and (d)(7) of this section. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest $[A]$ or A values for the alpha emitters or beta/gamma emitters, respectively.

(g) *Shipping papers and labeling.* For mixtures of radionuclides, the radionuclides (n) that must be shown on

shipping papers and labels in accordance with §§ 172.203 and 172.403 of this subchapter, respectively, must be determined on the basis of the following formula:

$$\sum_{i=1}^n \frac{a_{(i)}}{A_{(i)}} \geq 0.95 \sum_{i=1}^{n+m} \frac{a_{(i)}}{A_{(i)}}$$

Where:

$n + m$ represents all the radionuclides in the mixture;

m are the radionuclides that do not need to be considered;

$a_{(i)}$ is the activity of radionuclide i in the mixture; and

$A_{(i)}$ is the A_1 or A_2 value, as appropriate for radionuclide i .

(h) Tables 7 and 8 are as follows:

TABLE 7.—GENERAL VALUES FOR A_1 AND A_2

Radioactive contents	A_1		A_2	
	(TBq)	(Ci)	(TBq)	(Ci)
1. Only beta or gamma emitting nuclides are known to be present	1×10^{-1}	2.7×10^0	2×10^{-2}	5.4×10^{-1}
2. Only alpha emitting nuclides are known to be present	2×10^{-1}	5.4×10^0	9×10^{-3}	2.4×10^{-2}
3. No relevant data are available	1×10^{-3}	2.7×10^{-2}	9×10^{-5}	2.4×10^{-3}

TABLE 8.—GENERAL EXEMPTION VALUES

Radioactive contents	Activity concentration for exempt material		Activity limits for exempt consignments	
	(Bq/g)	(Ci/g)	(Bq)	(Ci)
1. Only beta or gamma emitting nuclides are known to be present	1×10^1	2.7×10^{-10}	1×10^4	2.7×10^{-7}
2. Only alpha emitting nuclides are known to be present	1×10^{-1}	2.7×10^{-12}	1×10^3	2.7×10^{-8}
3. No relevant data are available	1×10^{-1}	2.7×10^{-12}	1×10^3	2.7×10^{-8}

■ 30. Section 173.435 is revised to read as follows:

§ 173.435 Table of A_1 and A_2 values for radionuclides.

The table of A_1 and A_2 values for radionuclides is as follows:

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

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Ac-227 (a)		9.0×10 ⁻¹	2.4×10 ¹	9.0×10 ⁻⁵	2.4×10 ⁻³	2.7	7.2×10 ¹
Ac-228		6.0×10 ⁻¹	1.6×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	8.4×10 ⁴	2.2×10 ⁶
Ag-105	Silver (47)	2.0	5.4×10 ¹	2.0	5.4×10 ¹	1.1×10 ³	3.0×10 ⁴
Ag-108m (a)		7.0×10 ⁻¹	1.9×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	9.7×10 ⁻¹	2.6×10 ¹
Ag-110m (a)		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	1.8×10 ²	4.7×10 ³
Ag-111		2.0	5.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	5.8×10 ³	1.6×10 ⁵
Al-26	Aluminum (13)	1.0×10 ⁻¹	2.7	1.0×10 ⁻¹	2.7	7.0×10 ⁻⁴	1.9×10 ⁻²
Am-241	Americium (95)	1.0×10 ¹	2.7×10 ²	1.0×10 ⁻³	2.7×10 ⁻²	1.3×10 ⁻¹	3.4
Am-242m (a)		1.0×10 ¹	2.7×10 ²	1.0×10 ⁻³	2.7×10 ⁻²	3.6×10 ⁻¹	1.0×10 ¹
Am-243 (a)		5.0	1.4×10 ²	1.0×10 ⁻³	2.7×10 ⁻²	7.4×10 ⁻³	2.0×10 ⁻¹
Ar-37	Argon (18)	4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	3.7×10 ³	9.9×10 ⁴
Ar-39		4.0×10 ¹	1.1×10 ³	2.0×10 ¹	5.4×10 ²	1.3	3.4×10 ¹
Ar-41		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	1.5×10 ⁶	4.2×10 ⁷
As-72	Arsenic (33)	3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	6.2×10 ⁴	1.7×10 ⁶
As-73		4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	8.2×10 ²	2.2×10 ⁴
As-74		1.0	2.7×10 ¹	9.0×10 ⁻¹	2.4×10 ¹	3.7×10 ³	9.9×10 ⁴
As-76		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	5.8×10 ⁴	1.6×10 ⁶
As-77		2.0×10 ¹	5.4×10 ²	7.0×10 ⁻¹	1.9×10 ¹	3.9×10 ⁴	1.0×10 ⁶
At-211 (a)	Astatine (85)	2.0×10 ¹	5.4×10 ²	5.0×10 ⁻¹	1.4×10 ¹	7.6×10 ⁴	2.1×10 ⁶
Au-193	Gold (79)	7.0	1.9×10 ²	2.0	5.4×10 ¹	3.4×10 ⁴	9.2×10 ⁵
Au-194		1.0	2.7×10 ¹	1.0	2.7×10 ¹	1.5×10 ⁴	4.1×10 ⁵
Au-195		1.0×10 ¹	2.7×10 ²	6.0	1.6×10 ²	1.4×10 ²	3.7×10 ³
Au-198		1.0	2.7×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	9.0×10 ³	2.4×10 ⁵
Au-199		1.0×10 ¹	2.7×10 ²	6.0×10 ⁻¹	1.6×10 ¹	7.7×10 ³	2.1×10 ⁵
Ba-131 (a)	Barium (56)	2.0	5.4×10 ¹	2.0	5.4×10 ¹	3.1×10 ³	8.4×10 ⁴
Ba-133		3.0	8.1×10 ¹	3.0	8.1×10 ¹	9.4	2.6×10 ²
Ba-133m		2.0×10 ¹	5.4×10 ²	6.0×10 ⁻¹	1.6×10 ¹	2.2×10 ⁴	6.1×10 ⁵
Ba-140 (a)		5.0×10 ⁻¹	1.4×10 ¹	3.0×10 ⁻¹	8.1	2.7×10 ³	7.3×10 ⁴
Be-7	Beryllium (4)	2.0×10 ¹	5.4×10 ²	2.0×10 ¹	5.4×10 ²	1.3×10 ⁴	3.5×10 ⁵
Be-10		4.0×10 ¹	1.1×10 ³	6.0×10 ⁻¹	1.6×10 ¹	8.3×10 ⁻⁴	2.2×10 ⁻²
Bi-205	Bismuth (83)	7.0×10 ⁻¹	1.9×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	1.5×10 ⁻³	4.2×10 ⁻⁴
Bi-206		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	3.8×10 ³	1.0×10 ⁵
Bi-207		7.0×10 ⁻¹	1.9×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	1.9	5.2×10 ¹
Bi-210		1.0	2.7×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	4.6×10 ³	1.2×10 ⁵
Bi-210m (a)		6.0×10 ⁻¹	1.6×10 ¹	2.0×10 ⁻²	5.4×10 ⁻¹	2.1×10 ⁻⁵	5.7×10 ⁻⁴
Bi-212 (a)		7.0×10 ⁻¹	1.9×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	5.4×10 ⁵	1.5×10 ⁷
Bk-247	Berkelium (97)	8.0	2.2×10 ²	8.0×10 ⁻⁴	2.2×10 ⁻²	3.8×10 ⁻²	1.0
Bk-249 (a)		4.0×10 ¹	1.1×10 ³	3.0×10 ⁻¹	8.1	6.1×10 ¹	1.6×10 ³
Br-76	Bromine (35)	4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	9.4×10 ⁴	2.5×10 ⁶
Br-77		3.0	8.1×10 ¹	3.0	8.1×10 ¹	2.6×10 ⁴	7.1×10 ⁵
Br-82		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁴	1.1×10 ⁶
C-11	Carbon (6)	1.0	2.7×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	3.1×10 ⁷	8.4×10 ⁸
C-14		4.0×10 ¹	1.1×10 ³	3.0	8.1×10 ¹	1.6×10 ⁻¹	4.5
Ca-41	Calcium (20)	Unlimited	Unlimited	Unlimited	Unlimited	3.1×10 ⁻³	8.5×10 ⁻²
Ca-45		4.0×10 ¹	1.1×10 ³	1.0	2.7×10 ¹	6.6×10 ²	1.8×10 ⁴
Ca-47 (a)		3.0	8.1×10 ¹	3.0×10 ⁻¹	8.1	2.3×10 ⁴	6.1×10 ⁵
Cd-109	Cadmium (48)	3.0×10 ¹	8.1×10 ²	2.0	5.4×10 ¹	9.6×10 ¹	2.6×10 ³
Cd-113m		4.0×10 ¹	1.1×10 ³	5.0×10 ⁻¹	1.4×10 ¹	8.3	2.2×10 ²
Cd-115 (a)		3.0	8.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	1.9×10 ⁴	5.1×10 ⁵
Cd-115m		5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	9.4×10 ²	2.5×10 ⁴
Ce-139	Cerium (58)	7.0	1.9×10 ²	2.0	5.4×10 ¹	2.5×10 ²	6.8×10 ³
Ce-141		2.0×10 ¹	5.4×10 ²	6.0×10 ⁻¹	1.6×10 ¹	1.1×10 ³	2.8×10 ⁴
Ce-143		9.0×10 ⁻¹	2.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	2.5×10 ⁴	6.6×10 ⁵
Ce-144 (a)		2.0×10 ⁻¹	5.4	2.0×10 ⁻¹	5.4	1.2×10 ²	3.2×10 ³
Cf-248	Californium (98)	4.0×10 ¹	1.1×10 ³	6.0×10 ⁻³	1.6×10 ⁻¹	5.8×10 ¹	1.6×10 ³
Cf-249		3.0	8.1×10 ¹	8.0×10 ⁻⁴	2.2×10 ⁻²	1.5×10 ⁻¹	4.1
Cf-250		2.0×10 ¹	5.4×10 ²	2.0×10 ⁻³	5.4×10 ⁻²	4.0	1.1×10 ²
Cf-251		7.0	1.9×10 ²	7.0×10 ⁻⁴	1.9×10 ⁻²	5.9×10 ⁻²	1.6
Cf-252 (h)		5.0×10 ⁻²	1.4	3.0×10 ⁻³	8.1×10 ⁻³	2.0×10 ¹	5.4×10 ²
Cf-253 (a)		4.0×10 ¹	1.1×10 ³	4.0×10 ⁻²	1.1	1.1×10 ³	2.9×10 ⁴
Cf-254		1.0×10 ⁻³	2.7×10 ⁻²	1.0×10 ⁻³	2.7×10 ⁻²	3.1×10 ²	8.5×10 ³
Cl-36	Chlorine (17)	1.0×10 ¹	2.7×10 ²	6.0×10 ⁻¹	1.6×10 ¹	1.2×10 ⁻³	3.3×10 ⁻²
Cl-38		2.0×10 ⁻¹	5.4	2.0×10 ⁻¹	5.4	4.9×10 ⁶	1.3×10 ⁸
Cm-240	Curium (96)	4.0×10 ¹	1.1×10 ³	2.0×10 ⁻²	5.4×10 ⁻¹	7.5×10 ²	2.0×10 ⁴
Cm-241		2.0	5.4×10 ¹	1.0	2.7×10 ¹	6.1×10 ²	1.7×10 ⁴
Cm-242		4.0×10 ¹	1.1×10 ³	1.0×10 ⁻²	2.7×10 ⁻¹	1.2×10 ²	3.3×10 ³
Cm-243		9.0	2.4×10 ²	1.0×10 ⁻³	2.7×10 ⁻²	1.9×10 ⁻³	5.2×10 ⁻¹
Cm-244		2.0×10 ¹	5.4×10 ²	2.0×10 ⁻³	5.4×10 ⁻²	3.0	8.1×10 ¹
Cm-245		9.0	2.4×10 ²	9.0×10 ⁻⁴	2.4×10 ⁻²	6.4×10 ⁻³	1.7×10 ⁻¹
Cm-246		9.0	2.4×10 ²	9.0×10 ⁻⁴	2.4×10 ⁻²	1.1×10 ⁻²	3.1×10 ⁻¹
Cm-247 (a)		3.0	8.1×10 ¹	1.0×10 ⁻³	2.7×10 ⁻²	3.4×10 ⁻⁶	9.3×10 ⁻⁵
Cm-248		2.0×10 ⁻²	5.4×10 ⁻¹	3.0×10 ⁻⁴	8.1×10 ⁻³	1.6×10 ⁻⁵	4.2×10 ⁻³

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Co-55	Cobalt (27)	5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	1.1×10 ⁵	3.1×10 ⁶
Co-56		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	1.1×10 ³	3.0×10 ⁴
Co-57		1.0×10 ¹	2.7×10 ²	1.0×10 ¹	2.7×10 ²	3.1×10 ²	8.4×10 ³
Co-58		1.0	2.7×10 ¹	1.0	2.7×10 ¹	1.2×10 ³	3.2×10 ⁴
Co-58m		4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	2.2×10 ⁵	5.9×10 ⁶
Co-60		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	4.2×10 ¹	1.1×10 ³
Cr-51	Chromium (24)	3.0×10 ¹	8.1×10 ²	3.0×10 ¹	8.1×10 ²	3.4×10 ³	9.2×10 ⁴
Cs-129	Cesium (55)	4.0	1.1×10 ²	4.0	1.1×10 ²	2.8×10 ⁴	7.6×10 ⁵
Cs-131		3.0×10 ¹	8.1×10 ²	3.0×10 ¹	8.1×10 ²	3.8×10 ³	1.0×10 ⁵
Cs-132		1.0	2.7×10 ¹	1.0	2.7×10 ¹	5.7×10 ³	1.5×10 ⁵
Cs-134		7.0×10 ⁻¹	1.9×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	4.8×10 ¹	1.3×10 ³
Cs-134m		4.0×10 ¹	1.1×10 ³	6.0×10 ⁻¹	1.6×10 ¹	3.0×10 ⁵	8.0×10 ⁶
Cs-135		4.0×10 ¹	1.1×10 ³	1.0	2.7×10 ¹	4.3×10 ⁻⁵	1.2×10 ⁻³
Cs-136		5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	2.7×10 ³	7.3×10 ⁴
Cs-137 (a)		2.0	5.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	3.2	8.7×10 ¹
Cu-64	Copper (29)	6.0	1.6×10 ²	1.0	2.7×10 ¹	1.4×10 ⁵	3.9×10 ⁶
Dy-159	Dysprosium (66)	1.0×10 ¹	2.7×10 ²	7.0×10 ⁻¹	1.9×10 ¹	2.8×10 ⁴	7.6×10 ⁵
Dy-165		2.0×10 ¹	5.4×10 ²	2.0×10 ¹	5.4×10 ²	2.1×10 ²	5.7×10 ³
Dy-166 (a)		9.0×10 ⁻¹	2.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	3.0×10 ⁵	8.2×10 ⁶
Er-169	Erbium (68)	4.0×10 ¹	1.1×10 ³	3.0×10 ⁻¹	8.1	8.6×10 ³	2.3×10 ⁵
Er-171		8.0×10 ⁻¹	2.2×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	9.0×10 ⁴	6.3×10 ⁴
Eu-147	Europium (63)	2.0	5.4×10 ¹	2.0	5.4×10 ¹	1.4×10 ³	2.4×10 ⁵
Eu-148		5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	6.0×10 ³	3.7×10 ⁴
Eu-149		2.0×10 ¹	5.4×10 ²	2.0×10 ¹	5.4×10 ²	3.5×10 ²	1.6×10 ⁴
Eu-150 (short lived)		2.0	5.4×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	6.1×10 ⁴	1.6×10 ⁶
Eu-150 (long lived)		7 × 10 ⁻¹	1.9×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	6.1×10 ⁴	1.6×10 ⁶
Eu-152		1.0	2.7×10 ¹	1.0	2.7×10 ¹	6.5	1.8×10 ²
Eu-152m		8.0×10 ⁻¹	2.2×10 ¹	8.0×10 ⁻¹	2.2×10 ¹	8.2×10 ⁴	2.2×10 ⁶
Eu-154		9.0×10 ⁻¹	2.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	9.8	2.6×10 ²
Eu-155		2.0×10 ¹	5.4×10 ²	3.0	8.1×10 ¹	1.8×10 ¹	4.9×10 ²
Eu-156		7.0×10 ⁻¹	1.9×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	2.0×10 ³	5.5×10 ⁴
F-18	Fluorine (9)	1.0	2.7×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	3.5×10 ⁶	9.5×10 ⁷
Fe-52 (a)	Iron (26)	3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	2.7×10 ⁵	7.3×10 ⁶
Fe-55		4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	8.8×10 ¹	2.4×10 ³
Fe-59		9.0×10 ⁻¹	2.4×10 ¹	9.0×10 ⁻¹	2.4×10 ¹	1.8×10 ³	5.0×10 ⁴
Fe-60 (a)		4.0×10 ¹	1.1×10 ³	2.0×10 ⁻¹	5.4	7.4×10 ⁻⁴	2.0×10 ⁻²
Ga-67	Gallium (31)	7.0	1.9×10 ²	3.0	8.1×10 ¹	2.2×10 ⁴	6.0×10 ⁵
Ga-68		5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	1.5×10 ⁶	4.1×10 ⁷
Ga-72		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	1.1×10 ⁵	3.1×10 ⁶
Gd-146 (a)	Gadolinium (64)	5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	6.9×10 ²	1.9×10 ⁴
Gd-148		2.0×10 ¹	5.4×10 ²	2.0×10 ⁻³	5.4×10 ⁻²	1.2	3.2×10 ¹
Gd-153		1.0×10 ¹	2.7×10 ²	9.0	2.4×10 ²	1.3×10 ²	3.5×10 ³
Gd-159		3.0	8.1×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	3.9×10 ⁴	1.1×10 ⁶
Ge-68 (a)	Germanium (32)	5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	2.6×10 ²	7.1×10 ³
Ge-71		4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	5.8×10 ³	1.6×10 ⁵
Ge-77		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	1.3×10 ⁵	3.6×10 ⁶
Hf-172 (a)	Hafnium (72)	6.0×10 ⁻¹	1.6×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	4.1×10 ¹	1.1×10 ³
Hf-175		3.0	8.1×10 ¹	3.0	8.1×10 ¹	3.9×10 ²	1.1×10 ⁴
Hf-181		2.0	5.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	6.3×10 ²	1.7×10 ⁴
Hf-182		Unlimited	Unlimited	Unlimited	Unlimited	8.1×10 ⁻⁶	2.2×10 ⁻⁴
Hg-194 (a)	Mercury (80)	1.0	2.7×10 ¹	1.0	2.7×10 ¹	1.3×10 ⁻¹	3.5
Hg-195m (a)		3.0	8.1×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	1.5×10 ⁴	4.0×10 ⁵
Hg-197		2.0×10 ¹	5.4×10 ²	1.0×10 ¹	2.7×10 ²	9.2×10 ³	2.5×10 ⁵
Hg-197m		1.0×10 ¹	2.7×10 ²	4.0×10 ⁻¹	1.1×10 ¹	2.5×10 ⁴	6.7×10 ⁵
Hg-203		5.0	1.4×10 ²	1.0	2.7×10 ¹	5.1×10 ²	1.4×10 ⁴
Ho-166	Holmium (67)	4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	2.6×10 ⁴	7.0×10 ⁵
Ho-166m		6.0×10 ⁻¹	1.6×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	6.6×10 ⁻²	1.8
I-123	Iodine (53)	6.0	1.6×10 ²	3.0	8.1×10 ¹	7.1×10 ⁴	1.9×10 ⁶
I-124		1.0	2.7×10 ¹	1.0	2.7×10 ¹	9.3×10 ³	2.5×10 ⁵
I-125		2.0×10 ¹	5.4×10 ²	3.0	8.1×10 ¹	6.4×10 ²	1.7×10 ⁴
I-126		2.0	5.4×10 ¹	1.0	2.7×10 ¹	2.9×10 ³	8.0×10 ⁴
I-129		Unlimited	Unlimited	Unlimited	Unlimited	6.5×10 ⁻⁶	1.8×10 ⁻⁴
I-131		3.0	8.1×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	4.6×10 ³	1.2×10 ⁵
I-132		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	3.8×10 ⁵	1.0×10 ⁷
I-133		7.0×10 ⁻¹	1.9×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	4.2×10 ⁴	1.1×10 ⁶
I-134		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	9.9×10 ⁵	2.7×10 ⁷
I-135 (a)		6.0×10 ⁻¹	1.6×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	1.3×10 ⁵	3.5×10 ⁶
In-111	Indium (49)	3.0	8.1×10 ¹	3.0	8.1×10 ¹	1.5×10 ⁴	4.2×10 ⁵
In-113m		4.0	1.1×10 ²	2.0	5.4×10 ¹	6.2×10 ⁵	1.7×10 ⁷

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
In-114m (a)		1.0×10 ¹	2.7×10 ²	5.0×10 ⁻¹	1.4×10 ¹	8.6×10 ²	2.3×10 ⁴
In-115m		7.0	1.9×10 ³	1.0	2.7×10 ¹	2.2×10 ⁵	6.1×10 ⁶
Ir-189 (a)	Iridium (77)	1.0×10 ¹	2.7×10 ²	1.0×10 ¹	2.7×10 ²	1.9×10 ³	5.2×10 ⁴
Ir-190		7.0×10 ⁻¹	1.9×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	2.3×10 ³	6.2×10 ⁴
Ir-192 (c)		1.0	2.7×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	3.4×10 ²	9.2×10 ³
Ir-194		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	3.1×10 ⁴	8.4×10 ⁵
K-40	Potassium (19)	9.0×10 ⁻¹	2.4×10 ¹	9.0×10 ⁻¹	2.4×10 ¹	2.4×10 ⁻⁷	6.4×10 ⁻⁶
K-42		2.0×10 ⁻¹	5.4	2.0×10 ⁻¹	5.4	2.2×10 ⁵	6.0×10 ⁶
K-43		7.0×10 ⁻¹	1.9×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	1.2×10 ⁵	3.3×10 ⁶
Kr-81	Krypton (36)	4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	7.8×10 ⁻⁴	2.1×10 ⁻²
Kr-85		1.0×10 ¹	2.7×10 ²	1.0×10 ¹	2.7×10 ²	1.5×10 ¹	3.9×10 ²
Kr-85m		8.0	2.2×10 ²	3.0	8.1×10 ¹	3.0×10 ⁵	8.2×10 ⁶
Kr-87		2.0×10 ⁻¹	5.4	2.0×10 ⁻¹	5.4	1.0×10 ⁶	2.8×10 ⁷
La-137	Lanthanum (57)	3.0×10 ¹	8.1×10 ²	6.0	1.6×10 ²	1.6×10 ⁻³	4.4×10 ⁻²
La-140		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	2.1×10 ⁴	5.6×10 ⁵
Lu-172	Lutetium (71)	6.0×10 ⁻¹	1.6×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	4.2×10 ³	1.1×10 ⁵
Lu-173		8.0	2.2×10 ²	8.0	2.2×10 ²	5.6×10 ¹	1.5×10 ³
Lu-174		9.0	2.4×10 ²	9.0	2.4×10 ²	2.3×10 ¹	6.2×10 ²
Lu-174m		2.0×10 ¹	5.4×10 ²	1.0×10 ¹	2.7×10 ²	2.0×10 ²	5.3×10 ³
Lu-177		3.0×10 ¹	8.1×10 ²	7.0×10 ⁻¹	1.9×10 ¹	4.1×10 ³	1.1×10 ⁵
Mg-28 (a)	Magnesium (12)	3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	2.0×10 ⁵	5.4×10 ⁶
Mn-52	Manganese (25)	3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	1.6×10 ⁴	4.4×10 ⁵
Mn-53		Unlimited	Unlimited	Unlimited	Unlimited	6.8×10 ⁻⁵	1.8×10 ⁻³
Mn-54		1.0	2.7×10 ¹	1.0	2.7×10 ¹	2.9×10 ²	7.7×10 ³
Mn-56		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	8.0×10 ⁵	2.2×10 ⁷
Mo-93	Molybdenum (42)	4.0×10 ¹	1.1×10 ³	2.0×10 ¹	5.4×10 ²	4.1×10 ⁻²	1.1
Mo-99 (a) (i)		1.0	2.7×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	1.8×10 ⁴	4.8×10 ⁵
N-13	Nitrogen (7)	9.0×10 ⁻¹	2.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	5.4×10 ⁷	1.5×10 ⁹
Na-22	Sodium (11)	5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	2.3×10 ²	6.3×10 ³
Na-24		2.0×10 ⁻¹	5.4	2.0×10 ⁻¹	5.4	3.2×10 ⁵	8.7×10 ⁶
Nb-93m	Niobium (41)	4.0×10 ¹	1.1×10 ³	3.0×10 ¹	8.1×10 ²	8.8	2.4×10 ²
Nb-94		7.0×10 ⁻¹	1.9×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	6.9×10 ⁻³	1.9×10 ⁻¹
Nb-95		1.0	2.7×10 ¹	1.0	2.7×10 ¹	1.5×10 ³	3.9×10 ⁴
Nb-97		9.0×10 ⁻¹	2.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	9.9×10 ⁵	2.7×10 ⁷
Nd-147	Neodymium (60)	6.0	1.6×10 ²	6.0×10 ⁻¹	1.6×10 ¹	3.0×10 ³	8.1×10 ⁴
Nd-149		6.0×10 ⁻¹	1.6×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	4.5×10 ⁵	1.2×10 ⁷
Ni-59	Nickel (28)	Unlimited	Unlimited	Unlimited	Unlimited	3.0×10 ⁻³	8.0×10 ⁻²
Ni-63		4.0×10 ¹	1.1×10 ³	3.0×10 ¹	8.1×10 ²	2.1	5.7×10 ¹
Ni-65		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	7.1×10 ⁵	1.9×10 ⁷
Np-235	Neptunium (93)	4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	5.2×10 ¹	1.4×10 ³
Np-236 (short-lived)		2.0×10 ¹	5.4×10 ²	2.0	5.4×10 ¹	4.7×10 ⁻⁴	1.3×10 ⁻²
Np-236 (long-lived)		9.0×10 ⁰	2.4×10 ²	2.0×10 ⁻²	5.4×10 ⁻¹	4.7×10 ⁻⁴	1.3×10 ⁻²
Np-237		2.0×10 ¹	5.4×10 ²	2.0×10 ⁻³	5.4×10 ⁻²	2.6×10 ⁻⁵	7.1×10 ⁻⁴
Np-239		7.0	1.9×10 ²	4.0×10 ⁻¹	1.1×10 ¹	8.6×10 ³	2.3×10 ⁵
Os-185	Osmium (76)	1.0	2.7×10 ¹	1.0	2.7×10 ¹	2.8×10 ²	7.5×10 ³
Os-191		1.0×10 ¹	2.7×10 ²	2.0	5.4×10 ¹	1.6×10 ³	4.4×10 ⁴
Os-191m		4.0×10 ¹	1.1×10 ³	3.0×10 ¹	8.1×10 ²	4.6×10 ⁴	1.3×10 ⁶
Os-193		2.0	5.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	2.0×10 ⁴	5.3×10 ⁵
Os-194 (a)		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	1.1×10 ¹	3.1×10 ²
P-32	Phosphorus (15)	5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	1.1×10 ⁴	2.9×10 ⁵
P-33		4.0×10 ¹	1.1×10 ³	1.0	2.7×10 ¹	5.8×10 ³	1.6×10 ⁵
Pa-230 (a)	Protactinium (91)	2.0	5.4×10 ¹	7.0×10 ⁻²	1.9	1.2×10 ³	3.3×10 ⁴
Pa-231		4.0	1.1×10 ²	4.0×10 ⁻⁴	1.1×10 ⁻²	1.7×10 ⁻³	4.7×10 ⁻²
Pa-233		5.0	1.4×10 ²	7.0×10 ⁻¹	1.9×10 ¹	7.7×10 ²	2.1×10 ⁴
Pb-201	Lead (82)	1.0	2.7×10 ¹	1.0	2.7×10 ¹	6.2×10 ⁴	1.7×10 ⁶
Pb-202		4.0×10 ¹	1.1×10 ³	2.0×10 ¹	5.4×10 ²	1.2×10 ⁻⁴	3.4×10 ⁻³
Pb-203		4.0	1.1×10 ²	3.0	8.1×10 ¹	1.1×10 ⁴	3.0×10 ⁵
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	4.5×10 ⁻⁶	1.2×10 ⁻⁴
Pb-210 (a)		1.0	2.7×10 ¹	5.0×10 ⁻²	1.4	2.8	7.6×10 ¹
Pb-212 (a)		7.0×10 ⁻¹	1.9×10 ¹	2.0×10 ⁻¹	5.4	5.1×10 ⁴	1.4×10 ⁶
Pd-103 (a)	Palladium (46)	4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	2.8×10 ³	7.5×10 ⁴
Pd-107		Unlimited	Unlimited	Unlimited	Unlimited	1.9×10 ⁻⁵	5.1×10 ⁻⁴
Pd-109		2.0	5.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	7.9×10 ⁴	2.1×10 ⁶
Pm-143	Promethium (61)	3.0	8.1×10 ¹	3.0	8.1×10 ¹	1.3×10 ²	3.4×10 ³
Pm-144		7.0×10 ⁻¹	1.9×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	9.2×10 ¹	2.5×10 ³
Pm-145		3.0×10 ¹	8.1×10 ²	1.0×10 ¹	2.7×10 ²	5.2	1.4×10 ²
Pm-147		4.0×10 ¹	1.1×10 ³	2.0	5.4×10 ¹	3.4×10 ¹	9.3×10 ²
Pm-148m (a)		8.0×10 ⁻¹	2.2×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	7.9×10 ²	2.1×10 ⁴
Pm-149		2.0	5.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	1.5×10 ⁴	4.0×10 ⁵
Pm-151		2.0	5.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	2.7×10 ⁴	7.3×10 ⁵

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Po-210	Polonium (84)	4.0×10 ¹	1.1×10 ³	2.0×10 ⁻²	5.4×10 ⁻¹	1.7×10 ²	4.5×10 ³
Pr-142	Praseodymium (59)	4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	4.3×10 ⁴	1.2×10 ⁶
Pr-143		3.0	8.1×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	2.5×10 ³	6.7×10 ⁴
Pt-188 (a)	Platinum (78)	1.0	2.7×10 ¹	8.0×10 ⁻¹	2.2×10 ¹	2.5×10 ³	6.8×10 ⁴
Pt-191		4.0	1.1×10 ²	3.0	8.1×10 ¹	8.7×10 ³	2.4×10 ⁵
Pt-193		4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	1.4	3.7×10 ¹
Pt-193m		4.0×10 ¹	1.1×10 ³	5.0×10 ⁻¹	1.4×10 ¹	5.8×10 ³	1.6×10 ⁵
Pt-195m		1.0×10 ¹	2.7×10 ²	5.0×10 ⁻¹	1.4×10 ¹	6.2×10 ³	1.7×10 ⁵
Pt-197		2.0×10 ¹	5.4×10 ²	6.0×10 ⁻¹	1.6×10 ¹	3.2×10 ⁴	8.7×10 ⁵
Pt-197m		1.0×10 ¹	2.7×10 ²	6.0×10 ⁻¹	1.6×10 ¹	3.7×10 ⁵	1.0×10 ⁷
Pu-236	Plutonium (94)	3.0×10 ¹	8.1×10 ²	3.0×10 ⁻³	8.1×10 ⁻²	2.0×10 ¹	5.3×10 ²
Pu-237		2.0×10 ¹	5.4×10 ²	2.0×10 ¹	5.4×10 ²	4.5×10 ²	1.2×10 ⁴
Pu-238		1.0×10 ¹	2.7×10 ²	1.0×10 ⁻³	2.7×10 ⁻²	6.3×10 ⁻¹	1.7×10 ¹
Pu-239		1.0×10 ¹	2.7×10 ²	1.0×10 ⁻³	2.7×10 ⁻²	2.3×10 ⁻³	6.2×10 ⁻²
Pu-240		1.0×10 ¹	2.7×10 ²	1.0×10 ⁻³	2.7×10 ⁻²	8.4×10 ⁻³	2.3×10 ⁻¹
Pu-241 (a)		4.0×10 ¹	1.1×10 ³	6.0×10 ⁻²	1.6	3.8	1.0×10 ²
Pu-242		1.0×10 ¹	2.7×10 ²	1.0×10 ⁻³	2.7×10 ⁻²	1.5×10 ⁻⁴	3.9×10 ⁻³
Pu-244 (a)		4.0×10 ⁻¹	1.1×10 ¹	1.0×10 ⁻³	2.7×10 ⁻²	6.7×10 ⁻⁷	1.8×10 ⁻⁵
Ra-223 (a)	Radium (88)	4.0×10 ⁻¹	1.1×10 ¹	7.0×10 ⁻³	1.9×10 ⁻¹	1.9×10 ⁴	5.1×10 ⁴
Ra-224 (a)		4.0×10 ⁻¹	1.1×10 ¹	2.0×10 ⁻²	5.4×10 ⁻¹	5.9×10 ³	1.6×10 ⁵
Ra-225 (a)		2.0×10 ⁻¹	5.4	4.0×10 ⁻³	1.1×10 ⁻¹	1.5×10 ³	3.9×10 ⁴
Ra-226 (a)		2.0×10 ⁻¹	5.4	3.0×10 ⁻³	8.1×10 ⁻²	3.7×10 ⁻²	1.0
Ra-228 (a)		6.0×10 ⁻¹	1.6×10 ¹	2.0×10 ⁻²	5.4×10 ⁻¹	1.0×10 ¹	2.7×10 ²
Rb-81	Rubidium (37)	2.0	5.4×10 ¹	8.0×10 ⁻¹	2.2×10 ¹	3.1×10 ⁵	8.4×10 ⁶
Rb-83 (a)		2.0	5.4×10 ¹	2.0	5.4×10 ¹	6.8×10 ²	1.8×10 ⁴
Rb-84		1.0	2.7×10 ¹	1.0	2.7×10 ¹	1.8×10 ³	4.7×10 ⁴
Rb-86		5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	3.0×10 ³	8.1×10 ⁴
Rb-87		Unlimited	Unlimited	Unlimited	Unlimited	3.2×10 ⁻⁹	8.6×10 ⁻⁸
Rb(nat)		Unlimited	Unlimited	Unlimited	Unlimited	6.7×10 ⁶	1.8×10 ⁸
Re-184	Rhenium (75)	1.0	2.7×10 ¹	1.0	2.7×10 ¹	6.9×10 ²	1.9×10 ⁴
Re-184m		3.0	8.1×10 ¹	1.0	2.7×10 ¹	1.6×10 ²	4.3×10 ³
Re-186		2.0	5.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	6.9×10 ³	1.9×10 ⁵
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	1.4×10 ⁻⁹	3.8×10 ⁻⁸
Re-188		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	3.6×10 ⁴	9.8×10 ⁵
Re-189 (a)		3.0	8.1×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	2.5×10 ⁴	6.8×10 ⁵
Re(nat)		Unlimited	Unlimited	Unlimited	Unlimited	0.0	2.4×10 ⁻⁸
Rh-99	Rhodium (45)	2.0	5.4×10 ¹	2.0	5.4×10 ¹	3.0×10 ³	8.2×10 ⁴
Rh-101		4.0	1.1×10 ²	3.0	8.1×10 ¹	4.1×10 ³	1.1×10 ⁵
Rh-102		5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	4.5×10 ¹	1.2×10 ³
Rh-102m		2.0	5.4×10 ¹	2.0	5.4×10 ¹	2.3×10 ²	6.2×10 ³
Rh-103m		4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	1.2×10 ⁶	3.3×10 ⁷
Rh-105		1.0×10 ¹	2.7×10 ²	8.0×10 ⁻¹	2.2×10 ¹	3.1×10 ⁴	8.4×10 ⁵
Rn-222 (a)	Radon (86)	3.0×10 ⁻¹	8.1	4.0×10 ⁻³	1.1×10 ⁻¹	5.7×10 ³	1.5×10 ⁵
Ru-97	Ruthenium (44)	5.0	1.4×10 ²	5.0	1.4×10 ²	1.7×10 ⁴	4.6×10 ⁵
Ru-103 (a)		2.0	5.4×10 ¹	2.0	5.4×10 ¹	1.2×10 ³	3.2×10 ⁴
Ru-105		1.0	2.7×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	2.5×10 ⁵	6.7×10 ⁶
Ru-106 (a)		2.0×10 ⁻¹	5.4	2.0×10 ⁻¹	5.4	1.2×10 ²	3.3×10 ³
S-35	Sulphur (16)	4.0×10 ¹	1.1×10 ³	3.0	8.1×10 ¹	1.6×10 ³	4.3×10 ⁴
Sb-122	Antimony (51)	4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	1.5×10 ⁴	4.0×10 ⁵
Sb-124		6.0×10 ⁻¹	1.6×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	6.5×10 ²	1.7×10 ⁴
Sb-125		2.0	5.4×10 ¹	1.0	2.7×10 ¹	3.9×10 ¹	1.0×10 ³
Sb-126		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	3.1×10 ³	8.4×10 ⁴
Sc-44	Scandium (21)	5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	6.7×10 ⁵	1.8×10 ⁷
Sc-46		5.0×10 ⁻¹	1.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	1.3×10 ³	3.4×10 ⁴
Sc-47		1.0×10 ¹	2.7×10 ²	7.0×10 ⁻¹	1.9×10 ¹	3.1×10 ⁴	8.3×10 ⁵
Sc-48		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	5.5×10 ⁴	1.5×10 ⁶
Se-75	Selenium (34)	3.0	8.1×10 ¹	3.0	8.1×10 ¹	5.4×10 ²	1.5×10 ⁴
Se-79		4.0×10 ¹	1.1×10 ³	2.0	5.4×10 ¹	2.6×10 ⁻³	7.0×10 ⁻²
Si-31	Silicon (14)	6.0×10 ⁻¹	1.6×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	1.4×10 ⁶	3.9×10 ⁷
Si-32		4.0×10 ¹	1.1×10 ³	5.0×10 ⁻¹	1.4×10 ¹	3.9	1.1×10 ²
Sm-145	Samarium (62)	1.0×10 ¹	2.7×10 ²	1.0×10 ¹	2.7×10 ²	9.8×10 ¹	2.6×10 ³
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	8.5×10 ⁻¹	2.3×10 ⁻⁸
Sm-151		4.0×10 ¹	1.1×10 ³	1.0×10 ¹	2.7×10 ²	9.7×10 ⁻¹	2.6×10 ¹
Sm-153		9.0	2.4×10 ²	6.0×10 ⁻¹	1.6×10 ¹	1.6×10 ⁴	4.4×10 ⁵
Sn-113 (a)	Tin (50)	4.0	1.1×10 ²	2.0	5.4×10 ¹	3.7×10 ²	1.0×10 ⁴
Sn-117m		7.0	1.9×10 ²	4.0×10 ⁻¹	1.1×10 ¹	3.0×10 ³	8.2×10 ⁴
Sn-119m		4.0×10 ¹	1.1×10 ³	3.0×10 ¹	8.1×10 ²	1.4×10 ²	3.7×10 ³
Sn-121m (a)		4.0×10 ¹	1.1×10 ³	9.0×10 ⁻¹	2.4×10 ¹	2.0	5.4×10 ¹
Sn-123		8.0×10 ⁻¹	2.2×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	3.0×10 ²	8.2×10 ³
Sn-125		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ³	1.1×10 ⁵
Sn-126 (a)		6.0×10 ⁻¹	1.6×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	1.0×10 ⁻³	2.8×10 ⁻²
Sr-82 (a)	Strontium (38)	2.0×10 ⁻¹	5.4	2.0×10 ⁻¹	5.4	2.3×10 ³	6.2×10 ⁴

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Sr-85		2.0	5.4×10 ¹	2.0	5.4×10 ¹	8.8×10 ²	2.4×10 ⁴
Sr-85m		5.0	1.4×10 ²	5.0	1.4×10 ²	1.2×10 ⁶	3.3×10 ⁷
Sr-87m		3.0	8.1×10 ¹	3.0	8.1×10 ¹	4.8×10 ⁵	1.3×10 ⁷
Sr-89		6.0×10 ⁻¹	1.6×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	1.1×10 ³	2.9×10 ⁴
Sr-90 (a)		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	5.1	1.4×10 ²
Sr-91 (a)		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	1.3×10 ⁵	3.6×10 ⁶
Sr-92 (a)		1.0	2.7×10 ¹	3.0×10 ⁻¹	8.1	4.7×10 ⁵	1.3×10 ⁷
T(H-3)	Tritium (1)	4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	3.6×10 ²	9.7×10 ³
Ta-178 (long-lived)	Tantalum (73)	1.0	2.7×10 ¹	8.0×10 ⁻¹	2.2×10 ¹	4.2×10 ⁶	1.1×10 ⁸
Ta-179		3.0×10 ¹	8.1×10 ²	3.0×10 ¹	8.1×10 ²	4.1×10 ¹	1.1×10 ³
Ta-182		9.0×10 ⁻¹	2.4×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	2.3×10 ⁵	6.2×10 ³
Tb-157	Terbium (65)	4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	5.6×10 ⁻¹	1.5×10 ¹
Tb-158		1.0	2.7×10 ¹	1.0	2.7×10 ¹	5.6×10 ⁻¹	1.5×10 ¹
Tb-160		1.0	2.7×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	4.2×10 ²	1.1×10 ⁴
Tc-95m (a)	Technetium (43)	2.0	5.4×10 ¹	2.0	5.4×10 ¹	8.3×10 ²	2.2×10 ⁴
Tc-96		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	1.2×10 ⁴	3.2×10 ⁵
Tc-96m (a)		4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	1.4×10 ⁶	3.8×10 ⁷
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	5.2×10 ⁻⁵	1.4×10 ⁻³
Tc-97m		4.0×10 ¹	1.1×10 ³	1.0	2.7×10 ¹	5.6×10 ²	1.5×10 ⁴
Tc-98		8.0×10 ⁻¹	2.2×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	3.2×10 ⁻⁵	8.7×10 ⁻⁴
Tc-99		4.0×10 ¹	1.1×10 ³	9.0×10 ⁻¹	2.4×10 ¹	6.3×10 ⁻⁴	1.7×10 ⁻²
Tc-99m		1.0×10 ¹	2.7×10 ²	4.0	1.1×10 ²	1.9×10 ⁵	5.3×10 ⁶
Te-121	Tellurium (52)	2.0	5.4×10 ¹	2.0	5.4×10 ¹	2.4×10 ³	6.4×10 ⁴
Te-121m		5.0	1.4×10 ²	3.0	8.1×10 ¹	2.6×10 ²	7.0×10 ³
Te-123m		8.0	2.2×10 ²	1.0	2.7×10 ¹	3.3×10 ²	8.9×10 ³
Te-125m		2.0×10 ¹	5.4×10 ²	9.0×10 ⁻¹	2.4×10 ¹	6.7×10 ²	1.8×10 ⁴
Te-127		2.0×10 ¹	5.4×10 ²	7.0×10 ⁻¹	1.9×10 ¹	9.8×10 ⁴	2.6×10 ⁶
Te-127m (a)		2.0×10 ¹	5.4×10 ²	5.0×10 ⁻¹	1.4×10 ¹	3.5×10 ²	9.4×10 ³
Te-129		7.0×10 ⁻¹	1.9×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	7.7×10 ⁵	2.1×10 ⁷
Te-129m (a)		8.0×10 ⁻¹	2.2×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	1.1×10 ³	3.0×10 ⁴
Te-131m (a)		7.0×10 ⁻¹	1.9×10 ¹	5.0×10 ⁻¹	1.4×10 ¹	3.0×10 ⁴	8.0×10 ⁵
Te-132 (a)		5.0×10 ⁻¹	1.4×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	1.1×10 ⁴	8.0×10 ⁵
Th-227	Thorium (90)	1.0×10 ¹	2.7×10 ²	5.0×10 ⁻³	1.4×10 ⁻¹	1.1×10 ³	3.1×10 ⁴
Th-228 (a)		5.0×10 ⁻¹	1.4×10 ¹	1.0×10 ⁻³	2.7×10 ⁻²	3.0×10 ¹	8.2×10 ²
Th-229		5.0	1.4×10 ²	5.0×10 ⁻⁴	1.4×10 ⁻²	7.9×10 ⁻³	2.1×10 ⁻¹
Th-230		1.0×10 ¹	2.7×10 ²	1.0×10 ⁻³	2.7×10 ⁻²	7.6×10 ⁻⁴	2.1×10 ⁻²
Th-231		4.0×10 ¹	1.1×10 ³	2.0×10 ⁻²	5.4×10 ⁻¹	2.0×10 ⁴	5.3×10 ⁵
Th-232		Unlimited	Unlimited	Unlimited	Unlimited	4.0×10 ⁻⁹	1.1×10 ⁻⁷
Th-234 (a)		3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	8.6×10 ²	2.3×10 ⁴
Th(nat)		Unlimited	Unlimited	Unlimited	Unlimited	8.1×10 ⁻⁹	2.2×10 ⁻⁷
Ti-44 (a)	Titanium (22)	5.0×10 ⁻¹	1.4×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	6.4	1.7×10 ²
Tl-200	Thallium (81)	9.0×10 ⁻¹	2.4×10 ¹	9.0×10 ⁻¹	2.4×10 ¹	2.2×10 ⁴	6.0×10 ⁵
Tl-201		1.0×10 ¹	2.7×10 ²	4.0	1.1×10 ²	7.9×10 ³	2.1×10 ⁵
Tl-202		2.0	5.4×10 ¹	2.0	5.4×10 ¹	2.0×10 ³	5.3×10 ⁴
Tl-204		1.0×10 ¹	2.7×10 ²	7.0×10 ⁻¹	1.9×10 ¹	1.7×10 ¹	4.6×10 ³
Tm-167	Thulium (69)	7.0	1.9×10 ²	8.0×10 ⁻¹	2.2×10 ¹	3.1×10 ³	8.5×10 ⁴
Tm-170		3.0	8.1×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	2.2×10 ²	6.0×10 ³
Tm-171		4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³
U-230 (fast lung absorption) (a)(d)	Uranium (92)	4.0×10 ¹	1.1×10 ³	1.0×10 ⁻¹	2.7	1.0×10 ³	2.7×10 ⁴
U-230 (medium lung absorption) (a)(e)		4.0×10 ¹	1.1×10 ³	4.0×10 ⁻³	1.1×10 ⁻¹	1.0×10 ³	2.7×10 ⁴
U-230 (slow lung absorption) (a)(f)		3.0×10 ¹	8.1×10 ²	3.0×10 ⁻³	8.1×10 ⁻²	1.0×10 ³	2.7×10 ⁴
U-232 (fast lung absorption) (d)		4.0×10 ¹	1.1×10 ³	1.0×10 ⁻²	2.7×10 ⁻¹	8.3×10 ⁻¹	2.2×10 ¹
U-232 (medium lung absorption) (e)		4.0×10 ¹	1.1×10 ³	7.0×10 ⁻³	1.9×10 ⁻¹	8.3×10 ⁻¹	2.2×10 ¹
U-232 (slow lung absorption) (f)		1.0×10 ¹	2.7×10 ²	1.0×10 ⁻³	2.7×10 ⁻²	8.3×10 ⁻¹	2.2×10 ¹
U-233 (fast lung absorption) (d)		4.0×10 ¹	1.1×10 ³	9.0×10 ⁻²	2.4	3.6×10 ⁻⁴	9.7×10 ⁻³
U-233 (medium lung absorption) (e)		4.0×10 ¹	1.1×10 ³	2.0×10 ⁻²	5.4×10 ⁻¹	3.6×10 ⁻⁴	9.7×10 ⁻³

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
U-233 (slow lung absorption) (f).	4.0×10 ¹	1.1×10 ³	6.0×10 ⁻³	1.6×10 ⁻¹	3.6×10 ⁻⁴	9.7×10 ⁻³
U-234 (fast lung absorption) (d).	4.0×10 ¹	1.1×10 ³	9.0×10 ⁻²	2.4	2.3×10 ⁻⁴	6.2×10 ⁻³
U-234 (medium lung absorption) (e).	4.0×10 ¹	1.1×10 ³	2.0×10 ⁻²	5.4×10 ⁻¹	2.3×10 ⁻⁴	6.2×10 ⁻³
U-234 (slow lung absorption) (f).	4.0×10 ¹	1.1×10 ³	6.0×10 ⁻³	1.6×10 ⁻¹	2.3×10 ⁻⁴	6.2×10 ⁻³
U-235 (all lung absorption types) (a),(d),(e),(f).	Unlimited	Unlimited	Unlimited	Unlimited	8.0×10 ⁻⁸	2.2×10 ⁻⁶
U-236 (fast lung absorption) (d).	Unlimited	Unlimited	Unlimited	Unlimited	2.4×10 ⁻⁶	6.5×10 ⁻⁵
U-236 (medium lung absorption) (e).	4.0×10 ¹	1.1×10 ³	2.0×10 ⁻²	5.4×10 ⁻¹	2.4×10 ⁻⁶	6.5×10 ⁻⁵
U-236 (slow lung absorption) (f).	4.0×10 ¹	1.1×10 ³	6.0×10 ⁻³	1.6×10 ⁻¹	2.4×10 ⁻⁶	6.5×10 ⁻⁵
U-238 (all lung absorption types) (d),(e),(f).	Unlimited	Unlimited	Unlimited	Unlimited	1.2×10 ⁻⁸	3.4×10 ⁻⁷
U (nat)	Unlimited	Unlimited	Unlimited	Unlimited	2.6×10 ⁻⁸	7.1×10 ⁻⁷
U (enriched to 20% or less)(g).	Unlimited	Unlimited	Unlimited	Unlimited	see § 173.434	see § 173.434
U (dep)	Unlimited	Unlimited	Unlimited	Unlimited	see § 173.434	see § 173.434
V-48	Vanadium (23)	4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	6.3×10 ³	1.7×10 ³
V-49	4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	3.0×10 ²	8.1×10 ¹
W-178 (a)	Tungsten (74)	9.0	2.4×10 ²	5.0	1.4×10 ²	1.3×10 ³	3.4×10 ⁴
W-181	3.0×10 ¹	8.1×10 ²	3.0×10 ¹	8.1×10 ²	2.2×10 ²	6.0×10 ³
W-185	4.0×10 ¹	1.1×10 ³	8.0×10 ⁻¹	2.2×10 ¹	3.5×10 ²	9.4×10 ³
W-187	2.0	5.4×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	2.6×10 ⁴	7.0×10 ⁵
W-188 (a)	4.0×10 ⁻¹	1.1×10 ¹	3.0×10 ⁻¹	8.1	3.7×10 ²	1.0×10 ³
Xe-122 (a)	Xenon (54)	4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	4.8×10 ⁴	1.3×10 ⁵
Xe-123	2.0	5.4×10 ¹	7.0×10 ⁻¹	1.9×10 ¹	4.4×10 ³	1.2×10 ⁷
Xe-127	4.0	1.1×10 ²	2.0	5.4×10 ¹	1.0×10 ³	2.8×10 ⁴
Xe-131m	4.0×10 ¹	1.1×10 ³	4.0×10 ¹	1.1×10 ³	3.1×10 ³	8.4×10 ⁴
Xe-133	2.0×10 ¹	5.4×10 ²	1.0×10 ¹	2.7×10 ²	6.9×10 ³	1.9×10 ⁵
Xe-135	3.0	8.1×10 ¹	2.0	5.4×10 ¹	9.5×10 ⁴	2.6×10 ⁶
Y-87 (a)	Yttrium (39)	1.0	2.7×10 ¹	1.0	2.7×10 ¹	1.7×10 ⁴	4.5×10 ⁵
Y-88	4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	5.2×10 ²	1.4×10 ⁴
Y-90	3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	2.0×10 ⁴	5.4×10 ⁵
Y-91	6.0×10 ⁻¹	1.6×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	9.1×10 ²	2.5×10 ⁴
Y-91m	2.0	5.4×10 ¹	2.0	5.4×10 ¹	1.5×10 ⁶	4.2×10 ⁷
Y-92	2.0×10 ⁻¹	5.4	2.0×10 ⁻¹	5.4	3.6×10 ⁵	9.6×10 ⁶
Y-93	3.0×10 ⁻¹	8.1	3.0×10 ⁻¹	8.1	1.2×10 ⁵	3.3×10 ⁶
Yb-169	Ytterbium (70)	4.0	1.1×10 ²	1.0	2.7×10 ¹	8.9×10 ³	2.4×10 ⁴
Yb-175	3.0×10 ¹	8.1×10 ²	9.0×10 ⁻¹	2.4×10 ¹	6.6×10 ³	1.8×10 ⁵
Zn-65	Zinc (30)	2.0	5.4×10 ¹	2.0	5.4×10 ¹	3.0×10 ²	8.2×10 ³
Zn-69	3.0	8.1×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	1.8×10 ⁶	4.9×10 ⁷
Zn-69m (a)	3.0	8.1×10 ¹	6.0×10 ⁻¹	1.6×10 ¹	1.2×10 ⁵	3.3×10 ⁶
Zr-88	Zirconium (40)	3.0	8.1×10 ¹	3.0	8.1×10 ¹	6.6×10 ²	1.8×10 ⁴
Zr-93	Unlimited	Unlimited	Unlimited	Unlimited	9.3×10 ⁻⁵	2.5×10 ⁻³
Zr-95 (a)	2.0	5.4×10 ¹	8.0×10 ⁻¹	2.2×10 ¹	7.9×10 ²	2.1×10 ⁴
Zr-97 (a)	4.0×10 ⁻¹	1.1×10 ¹	4.0×10 ⁻¹	1.1×10 ¹	7.1×10 ⁴	1.9×10 ⁶

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

^b (Reserved)

^c The quantity 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 notes (d) and (e) of this table.

^g These values apply to unirradiated uranium only.

^h A₁ = 0.1 TBq (2.7 Ci) and A₂ = 0.001 TBq (0.027 Ci) for Cf-252 for domestic use.

ⁱ A₂ = 0.74 TBq (20 Ci) for Mo-99 for domestic use.

■ 31. A new § 173.436 is added to read as follows:

§ 173.436 Exempt material activity concentrations and exempt consignment activity limits for radionuclides.

The Table of Exempt material activity concentrations and exempt consignment

activity limits for radionuclides is as follows:

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 (b)		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 (b)		1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Am-243 (b)		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 (b)		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 (b)		1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Bk-247	Berkelium (97)	1.0	2.7×10^{-11}	1.0×10^4	2.7×10^{-7}
Bk-249		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 (b)		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}

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)
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 ⁵	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
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 (b)		1.0×10 ¹	2.7×10 ⁻¹⁰	1.0×10 ⁴	2.7×10 ⁻⁷
Cu-64	Copper (29)	1.0×10 ³	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 ¹	2.7×10 ⁻¹⁰	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-152m		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 ¹	2.7×10 ⁻¹⁰	1.0×10 ⁶	2.7×10 ⁻⁵
Fe-59		1.0×10 ⁴	2.7×10 ⁻⁷	1.0×10 ⁶	2.7×10 ⁻⁵
Fe-60		1.0×10 ¹	2.7×10 ⁻¹⁰	1.0×10 ⁶	2.7×10 ⁻⁵
Ga-67	Gallium (31)	1.0×10 ²	2.7×10 ⁻⁹	1.0×10 ⁵	2.7×10 ⁻⁶
Ga-68		1.0×10 ²	2.7×10 ⁻⁹	1.0×10 ⁶	2.7×10 ⁻⁵
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 ⁵	2.7×10 ⁻⁶
Gd-148		1.0×10 ¹	2.7×10 ⁻¹⁰	1.0×10 ⁶	2.7×10 ⁻⁵
Gd-153		1.0×10 ¹	2.7×10 ⁻¹⁰	1.0×10 ⁴	2.7×10 ⁻⁷
Gd-159		1.0×10 ³	2.7×10 ⁻⁹	1.0×10 ⁷	2.7×10 ⁻⁴
Ge-68		1.0×10 ³	2.7×10 ⁻⁸	1.0×10 ⁶	2.7×10 ⁻⁵
Ge-71	Germanium (32)	1.0×10 ¹	2.7×10 ⁻¹⁰	1.0×10 ⁵	2.7×10 ⁻⁶
Ge-77		1.0×10 ⁴	2.7×10 ⁻⁷	1.0×10 ⁸	2.7×10 ⁻³
Hf-172		1.0×10 ¹	2.7×10 ⁻¹⁰	1.0×10 ⁵	2.7×10 ⁻⁶
Hf-175	Hafnium (72)	1.0×10 ¹	2.7×10 ⁻¹⁰	1.0×10 ⁶	2.7×10 ⁻⁵
Hf-181		1.0×10 ²	2.7×10 ⁻⁹	1.0×10 ⁶	2.7×10 ⁻⁵
Hf-182		1.0×10 ¹	2.7×10 ⁻¹⁰	1.0×10 ⁶	2.7×10 ⁻⁵
Hg-194		1.0×10 ²	2.7×10 ⁻⁹	1.0×10 ⁶	2.7×10 ⁻⁵
Hg-195m	Mercury (80)	1.0×10 ¹	2.7×10 ⁻¹⁰	1.0×10 ⁶	2.7×10 ⁻⁵
Hg-197		1.0×10 ²	2.7×10 ⁻⁹	1.0×10 ⁶	2.7×10 ⁻⁵
Hg-197m		1.0×10 ²	2.7×10 ⁻⁹	1.0×10 ⁷	2.7×10 ⁻⁴
Hg-203		1.0×10 ²	2.7×10 ⁻⁹	1.0×10 ⁶	2.7×10 ⁻⁵
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 ⁵	2.7×10 ⁻⁶
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

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)
I-126		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
I-129		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁵	2.7x10 ⁻⁶
I-131		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
I-132		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
I-133		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
I-134		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
I-135		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
In-111	Indium (49)	1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
In-113m		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
In-114m		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
In-115m		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Ir-189	Iridium (77)	1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁷	2.7x10 ⁻⁴
Ir-190		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
Ir-192		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁴	2.7x10 ⁻⁷
Ir-194		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁵	2.7x10 ⁻⁶
K-40	Potassium (19)	1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
K-42		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
K-43		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
Kr-81	Krypton (36)	1.0x10 ⁴	2.7x10 ⁻⁷	1.0x10 ⁷	2.7x10 ⁻⁴
Kr-85		1.0x10 ⁵	2.7x10 ⁻⁶	1.0x10 ⁴	2.7x10 ⁻⁷
Kr-85m		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ¹⁰	2.7x10 ⁻¹
Kr-87		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁹	2.7x10 ⁻²
La-137	Lanthanum (57)	1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
La-140		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Lu-172	Lutetium (71)	1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
Lu-173		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁷	2.7x10 ⁻⁴
Lu-174		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁷	2.7x10 ⁻⁴
Lu-174m		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁷	2.7x10 ⁻⁴
Lu-177		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Mg-28	Magnesium (12)	1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Mn-52	Manganese (25)	1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Mn-53		1.0x10 ⁴	2.7x10 ⁻⁷	1.0x10 ⁹	2.7x10 ⁻²
Mn-54		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
Mn-56		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Mo-93	Molybdenum (42)	1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁸	2.7x10 ⁻³
Mo-99		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
N-13	Nitrogen (7)	1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁹	2.7x10 ⁻²
Na-22	Sodium (11)	1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
Na-24		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Nb-93m	Niobium (41)	1.0x10 ⁴	2.7x10 ⁻⁷	1.0x10 ⁷	2.7x10 ⁻⁴
Nb-94		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁵
Nb-95		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁵
Nb-97		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁵
Nd-147	Neodymium (60)	1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Nd-149		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Ni-59	Nickel (28)	1.0x10 ⁴	2.7x10 ⁻⁷	1.0x10 ⁸	2.7x10 ⁻³
Ni-63		1.0x10 ⁵	2.7x10 ⁻⁶	1.0x10 ⁸	2.7x10 ⁻³
Ni-65		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
Np-235	Neptunium (93)	1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Np-236 (short-lived)		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Np-236 (long-lived)		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁵	2.7x10 ⁻⁶
Np-237 (b)		1.0	2.7x10 ⁻¹¹	1.0x10 ³	2.7x10 ⁻⁸
Np-239		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁷	2.7x10 ⁻⁴
Os-185	Osmium (76)	1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
Os-191		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁷	2.7x10 ⁻⁴
Os-191m		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Os-193		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Os-194		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁵	2.7x10 ⁻⁶
P-32	Phosphorus (15)	1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁵	2.7x10 ⁻⁶
P-33		1.0x10 ⁵	2.7x10 ⁻⁶	1.0x10 ⁸	2.7x10 ⁻³
Pa-230	Protactinium (91)	1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
Pa-231		1.0	2.7x10 ⁻¹¹	1.0x10 ³	2.7x10 ⁻⁸
Pa-233		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁷	2.7x10 ⁻⁴
Pb-201	Lead (82)	1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁶	2.7x10 ⁻⁵
Pb-202		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁶	2.7x10 ⁻⁵
Pb-203		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Pb-205		1.0x10 ⁴	2.7x10 ⁻⁷	1.0x10 ⁷	2.7x10 ⁻⁴
Pb-210 (b)		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁴	2.7x10 ⁻⁷
Pb-212 (b)		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Pd-103	Palladium (46)	1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁸	2.7x10 ⁻³

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)
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}
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 (b)	Radium (88)	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
Ra-224 (b)		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 (b)		1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
Ra-228 (b)		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(nat)		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(nat)		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 (b)	Radon (86)	1.0×10^1	2.7×10^{-10}	1.0×10^8	2.7×10^{-3}
Ru-97	Ruthenium (44)	1.0×10^3	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 (b)		1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
S-35	Sulphur (16)	1.0×10^3	2.7×10^{-6}	1.0×10^8	2.7×10^{-3}
Sb-122	Antimony (51)	1.0×10^2	2.7×10^{-9}	1.0×10^4	2.7×10^{-7}
Sb-124		1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Sb-125		1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Sb-126		1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Sc-44	Scandium (21)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Sc-46		1.0×10^1	2.7×10^{-10}	1.0×10^6	2.7×10^{-5}
Sc-47		1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Sc-48		1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
Se-75	Selenium (34)	1.0×10^2	2.7×10^{-9}	1.0×10^6	2.7×10^{-5}
Se-79		1.0×10^4	2.7×10^{-7}	1.0×10^7	2.7×10^{-4}
Si-31	Silicon (14)	1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Si-32		1.0×10^3	2.7×10^{-8}	1.0×10^6	2.7×10^{-5}
Sm-145	Samarium (62)	1.0×10^2	2.7×10^{-9}	1.0×10^7	2.7×10^{-4}

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)
Sm-147	Tin (50)	1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁴	2.7x10 ⁻⁷
Sm-151		1.0x10 ⁴	2.7x10 ⁻⁷	1.0x10 ⁸	2.7x10 ⁻³
Sm-153		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Sn-113		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Sn-117m		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Sn-119m		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Sn-121m		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Sn-123		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Sn-125		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Sn-126		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Sr-82	Strontium (38)	1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Sr-85		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Sr-85m		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Sr-87m		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Sr-89		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Sr-90 (b)		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Sr-91		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Sr-92		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
T(H-3)		1.0x10 ⁶	2.7x10 ⁻⁵	1.0x10 ⁹	2.7x10 ⁻²
Ta-178 (long-lived)		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Ta-179	Tantalum (73)	1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Ta-182		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Tb-157		1.0x10 ⁴	2.7x10 ⁻⁷	1.0x10 ⁸	2.7x10 ⁻³
Tb-158		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Tb-160		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Tc-95m		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Tc-96		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Tc-96m		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Tc-97		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Tc-97m		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Tc-98	Technetium (43)	1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Tc-99		1.0x10 ⁴	2.7x10 ⁻⁷	1.0x10 ⁸	2.7x10 ⁻³
Tc-99m		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Te-121		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Te-121m		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Te-123m		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Te-125m		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Te-127		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Te-127m		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Te-129		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Te-129m	Tellurium (52)	1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Te-131m		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Te-132		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Th-227		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Th-228 (b)		1.0	2.7x10 ⁻¹¹	1.0x10 ⁴	2.7x10 ⁻⁷
Th-229 (b)		1.0	2.7x10 ⁻¹¹	1.0x10 ⁴	2.7x10 ⁻⁷
Th-230		1.0	2.7x10 ⁻¹¹	1.0x10 ⁴	2.7x10 ⁻⁷
Th-231		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Th-232		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Th-234 (b)		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Th (nat) (b)	Thorium (90)	1.0	2.7x10 ⁻¹¹	1.0x10 ⁴	2.7x10 ⁻⁷
Ti-44		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Ti-200		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
Ti-201		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Ti-202		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Ti-204		1.0x10 ⁴	2.7x10 ⁻⁷	1.0x10 ⁸	2.7x10 ⁻³
Tm-167		1.0x10 ²	2.7x10 ⁻⁹	1.0x10 ⁶	2.7x10 ⁻⁵
Tm-170		1.0x10 ³	2.7x10 ⁻⁸	1.0x10 ⁷	2.7x10 ⁻⁴
Tm-171		1.0x10 ⁴	2.7x10 ⁻⁷	1.0x10 ⁸	2.7x10 ⁻³
U-230 (fast lung absorption) (b),(d)		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
U-230 (medium lung absorption) (e)	Uranium (92)	1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
U-230 (slow lung absorption) (f)		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
U-232 (fast lung absorption) (b),(d)		1.0	2.7x10 ⁻¹¹	1.0x10 ⁴	2.7x10 ⁻⁷
U-232 (medium lung absorption) (e)		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶
U-232 (slow lung absorption) (f)		1.0x10 ¹	2.7x10 ⁻¹⁰	1.0x10 ⁵	2.7x10 ⁻⁶

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
U-233 (fast lung absorption) (d).	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-233 (medium lung absorption) (e).	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
U-233 (slow lung absorption) (f).	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
U-234 (fast lung absorption) (d).	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-234 (medium lung absorption) (e).	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
U-234 (slow lung absorption) (f).	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}
U-235 (all lung absorption types) (b),(d),(e),(f).	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-236 (fast lung absorption) (d).	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-236 (medium lung absorption) (e).	1.0×10^2	2.7×10^{-9}	1.0×10^5	2.7×10^{-6}
U-236 (slow lung absorption) (f).	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U-238 (all lung absorption types) (b),(d),(e),(f).	1.0×10^1	2.7×10^{-10}	1.0×10^4	2.7×10^{-7}
U (nat) (b)	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U (enriched to 20% or less)(g).	1.0	2.7×10^{-11}	1.0×10^3	2.7×10^{-8}
U (dep)	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}
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 (70)	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	1.0×10^3	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 (b)	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 (b)	1.0×10^1	2.7×10^{-10}	1.0×10^5	2.7×10^{-6}

* [Reserved]

^b 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
 Cs-137 Ba-137m
 Ce-134 La-134
 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-220 Po-216
 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-226	Ra-222, Rn-218, Po-214
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-226, Ac-226, 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
U-240	Np-240m
Np-237	Pa-233
Am-242m	Am-242
Am-243	Np-239

^c[Reserved]

^aThese 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.

^bThese 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.

^cThese values apply to all compounds of uranium other than those specified in notes (d) and (e) of this table.

^dThese values apply to unirradiated uranium only.

■ 32. In § 173.441, the section title is revised, paragraph (d) is redesignated as paragraph (e) and revised and a new paragraph (d) is added to read as follows:

§ 173.441 Radiation level limitations and exclusive use provisions.

* * * * *

(d) Conveyance limits on the sum of package transport indices are as follows:

(1) Except for shipments by cargo aircraft only or by seagoing vessel, the sum of transport indices for a non-exclusive use shipment may not exceed 50.

(2) Where a consignment is transported under exclusive use, there is no limit on the sum of the transport indices aboard a single conveyance. The conditions of paragraphs (b)(2), (b)(3), (b)(4) and (c) must be met.

(3) Provisions for shipments of Class 7 (radioactive) materials by air are described in §§ 175.700–175.705 of this subchapter.

(4) Provisions for shipment of Class 7 (radioactive) materials by vessel are described in §§ 176.700–176.720 of this subchapter.

(e) A package exceeding the maximum surface radiation level or maximum transport index prescribed in paragraph (a) of this section may not be transported by aircraft.

■ 33. In § 173.443, paragraphs (a)(1) and (a)(2) are revised to read as follows:

§ 173.443 Contamination control.

(a) * * *

(1) Wiping an area of 300 cm² of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements must be taken in the most appropriate locations to yield a representative assessment of the non-fixed contamination levels. The amount of

radioactivity measured on any single wiping material, divided by the surface area wiped and divided by the efficiency of the wipe procedure (the fraction of removable contamination transferred from the surface to the absorbent material), may not exceed the limits set forth in Table 9 at any time during transport. For this purpose the actual wipe efficiency may be used, or the wipe efficiency may be assumed to be 0.10; or

(2) Alternatively, the level of non-fixed radioactive contamination may be determined by using other methods of equal or greater efficiency.

Table 9 is as follows:

TABLE 9.—NON-FIXED EXTERNAL RADIOACTIVE CONTAMINATION LIMITS FOR PACKAGES

Contaminant	Maximum permissible limits		
	Bq/cm ²	uCi/cm ²	dpm/cm ²
1. Beta and gamma emitters and low toxicity alpha emitters	4	10 ⁻⁴	220
2. All other alpha emitting radionuclides	0.4	10 ⁻⁵	22

* * * * *

■ 34. In § 173.447, paragraphs (a) and (b) are revised to read as follows:

§ 173.447 Storage during transportation—general requirements.

* * * * *

(a) The number of packages and overpacks bearing FISSILE labels stored in any one storage area, such as a transit area, terminal building, storeroom, waterfront pier, or assembly yard, must

be limited so that the total sum of the criticality safety indices in any individual group of such packages and overpacks does not exceed 50. Groups of such packages and overpacks must be stored so as to maintain a spacing of at least 6 m (20 feet) from all other groups of such packages and overpacks.

(b) Storage requirements for Class 7 (radioactive) material transported in vessels are described in subpart M of part 176 of this subchapter.

■ 35. Section 173.448 is revised to read as follows:

§ 173.448 General transportation requirements.

(a) Each shipment of Class 7 (radioactive) materials must be secured to prevent shifting during normal transportation conditions.

(b) Except as provided in §§ 174.81, 176.83, and 177.848 of this subchapter, or as otherwise required by the Competent Authority in the applicable certificate, a package or overpack of Class 7 (radioactive) materials may be carried among packaged general cargo without special stowage provisions, if—

(1) The heat output in watts does not exceed 0.1 times the minimum package dimension in centimeters; or

(2) The average surface heat flux of the package or overpack does not exceed 15 watts per square meter and the immediately surrounding cargo is not in sacks or bags or otherwise in a form that would seriously impede air circulation for heat removal.

(c) Packages or overpacks bearing labels prescribed in § 172.403 of this subchapter may not be carried in compartments occupied by passengers, except in those compartments exclusively reserved for couriers accompanying those packages.

(d) Mixing of different kinds of packages that include fissile packages is

Stan A. Huber Consultants, Inc. (SAHCI), New Lenox, IL.
Private Use - Transport to Temporary Job Sites

TO:	FROM:
Consignee	Shipper
Street	
Destination:	

[illegible]

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport by Highway, according to applicable international and national governmental regulations.


Signature _____

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading, the property described above in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination. If on its route, otherwise to deliver to another carrier on the route to said designation. It is mutually agreed as to each carrier of all or any of, said property over all or any portion of said route to destination and as to each party at any time interested in all or any said property, that every service to be performed thereunder shall be subject to all the bill of lading terms and conditions in the governing classification on the date of shipment. Shipper hereby certifies that he is familiar with all the bill of lading terms and conditions in the governing classification and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns

Shipper: Stan A. Huber Consultants, Inc.	Carrier:
Per:	Per:
Date:	Date:

SAMPLE - For Reference Only

SHIPPER'S DECLARATION FOR DANGEROUS GOODS (Provide at least two copies to the airline)

Shipper		Air Waybill No.			
		Page 1 of 1 Pages			
Consignee		Shipper's Reference Number (optional)			
					
<i>Two completed and signed copies of this Declaration must be handed to the operator.</i>		WARNING Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder, or an IATA cargo agent.			
TRANSPORT DETAILS					
This shipment is within the limitations prescribed for: (delete non-applicable)		Airport of Departure			
<table border="1"> <tr> <td>PASSENGER AND CARGO AIRCRAFT</td> <td>CARGO AIRCRAFT ONLY</td> </tr> </table>		PASSENGER AND CARGO AIRCRAFT	CARGO AIRCRAFT ONLY		
PASSENGER AND CARGO AIRCRAFT	CARGO AIRCRAFT ONLY				
Airport of Destination:		Shipment type: (delete non-applicable) <table border="1"> <tr> <td>NON-RADIOACTIVE</td> <td>RADIOACTIVE</td> </tr> </table>		NON-RADIOACTIVE	RADIOACTIVE
NON-RADIOACTIVE	RADIOACTIVE				

NATURE AND QUANTITY OF DANGEROUS GOODS							
Dangerous Goods Identification					Quantity and type of packaging	Packing Inst.	Authorization
Proper Shipping Name	Class or Division	UN or ID No.	Pack- ing Group	Subsidiary Risk			
SAMPLE - For Reference Only							
Additional Handling Information							
Emergency Telephone Number							
I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport according to applicable International and National Government Regulations.					Name/Title of Signatory Place and Date Signature (see warning above)		
IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.							

FedEx M-1421 9/97 LOGOS# 2041730848

Guidelines for Completing Form

(For complete details, see current IATA Dangerous Goods Regulations)

-- Form must be legible --

SHIPPER --- Enter name and address of shipper.

CONSIGNEE --- Enter the name and address of recipient.

PAGE OF PAGES --- Enter page number and total number of pages, i.e., Page 1 of 1 (for single page declaration).

TRANSPORT --- Delete the option that does not apply to this shipment.

SHIPMENT TYPE --- Delete the option that does not apply to this shipment.

PROPER SHIPPING NAME --- List the proper shipping name and, if applicable, the technical name in parenthesis.

CLASS OR DIVISION --- List the class or division number and, if applicable, compatibility group.

UN OR ID NUMBER --- List the UN or ID number, preceded with "UN" or "ID".

PACKING GROUP --- List the appropriate packing group, if applicable.

SUBSIDIARY RISK --- List the class or division number of the subsidiary risk, if applicable.

QUANTITY AND TYPE OF PACKAGING --- List the number of packages, the type of packaging, and the net quantity in each package, i.e., 1 fiberboard box X 2 kgs.

PACKING INSTRUCTIONS --- Enter the packing instruction number.

AUTHORIZATION --- Enter the words "Limited Quantity" if applicable; list any special provision(s) or approval(s) if applicable.

ADDITIONAL HANDLING INFORMATION --- Enter any required special handling information.

EMERGENCY TELEPHONE NUMBER --- Enter your 24-hour emergency contact number.

NAME/TITLE OF SIGNATORY --- Enter name and job title of shipper.

PLACE AND DATE --- Enter the city and date of shipment.

SIGNATURE --- Sign the form (must be complete signature).

All alterations must be signed with the same signature used to sign the declaration.

FedEx cannot make any changes/additions/deletions to this declaration except the Air Waybill number/Airport of Departure/Airport of Destination.

If you need assistance completing this form and/or with the marking and labelling requirements, contact the FedEx Dangerous Goods Hotline at 800 GO FEDEX, extension 1666.

OP-0871 6/99

FREIGHT CHARGES ARE COLLECT UNLESS MARKED PREPAID BELOW

☐ STRAIGHT BILL OF LADING—SHORT FORM—ORIGINAL—NOT NEGOTIABLE



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(1-800-762-3929)

DATE _____ PRO. NO. _____

B/L NO. _____ PAGE _____

SHIPPER NO.		TRAILER NO.	
SHIPPER NAME			
ADDRESS			
CITY		STATE	ZIP CODE
ORIGIN CITY (IF DIFFERENT THAN ABOVE)		STATE	ZIP CODE

CONSIGNEE NAME AND ADDRESS		
DESTINATION CITY	STATE	ZIP CODE
PHONE NO.		

INVOICEE		
ADDRESS		
CITY	STATE	ZIP CODE
ATTN:		

CUSTOMER NO.	STORE NO.	DEPT.
P.O. NO.		
SPECIAL INSTRUCTIONS		

[illegible][illegible]

MARK "X" IN "HM" COLUMN FOR HAZARDOUS MATERIALS

SINGLE SHIPMENT PICKUP ☐

PRINTED IN U.S.A.

FedEx Express Dangerous Goods Acceptance Checklist — 2003



Due to the regulatory discrepancies indicated, your shipment cannot be transported by FedEx.

Tracking No. _____ Date _____
Inspected By _____ Employee Number _____

- 1 ☐ For international shipments ensure Service Reference Guide shows "D" designated locations for Express products.
2 ☐ Complies with all applicable government variations (2.9.2)

Shipper's Declaration — Note: The tracking No. and the airport/city of departure and destination city may be completed by the shipper or Dangerous Goods Specialist. The declaration must have 3 copies and be typed or computer generated. (FX-12, FX-15).

- 3 ☐ Name and address of shipper (10.8.3.1)
4 ☐ Name and address of consignee (10.8.3.2)
5 ☐ Page of pages (10.8.3.4)
6 ☐ Correctly indicates whether packed within Passenger or Cargo Aircraft
Only limitations: Must be 3.0 TI or less per package, and for medical use to be acceptable for passenger aircraft (10.8.3.5, USG10)
7 ☐ Non-radioactive deleted (10.8.3.8)

Nature & Quantity of Dangerous Goods — This information must be entered in the order given (10.8.3.9).

- 8 ☐ Proper shipping name (10.8.3.9.1, step 1). The following, additional PSN may be used for US domestic carriage: Radioactive Material NOS, UN 2982; Radioactive Material, Special Form, NOS, UN 2974; Radioactive Material, Fissile, NOS, UN 2918; Thorium Metal, Pyrophoric, UN 2975; Thorium Nitrate, Solid, UN 2976; Uranium Metal, Pyrophoric, UN 2979; Uranyl Nitrate Hexahydrate Solution, UN 2980; Uranyl Nitrate, Solid, UN 2981
9 ☐ Class number 7 (10.8.3.9.1, step 2)
10 ☐ UN number, preceded by prefix "UN" (10.8.3.9.1, step 3)
11 ☐ Packing Group number, when applicable, corresponding to subsidiary risk (10.8.3.9.1, step 4)
12 ☐ Subsidiary risk(s), when applicable, corresponding to subsidiary risk label(s) applied (10.8.3.9.1, step 5)
13 ☐ Name or symbol of radionuclide(s) (i.e., Ir-192, Mo-99) (10.8.3.9.2(a), step 6)
14 ☐ Description of the physical and chemical form, or "Special Form" (if not already included in Proper Shipping Name) (10.8.3.9.2(b), step 6)
15 ☐ Number and type of package (i.e., 1 Type A, 1 Type B, 1 IP1, 1 IP2, 1 IP3) (10.8.3.9.2, step 7)

- 16 ☐ Activity of radionuclide(s) in SI units (GBq, MBq, TBq, etc.) (10.8.3.9.2, step 7)
17 ☐ Category of label (i.e., White I, Yellow II or Yellow III) (10.8.3.9.3, step 9)
18 ☐ For Yellow II and Yellow III only, the TI to one decimal place and dimensions of the package (SI units).
19 ☐ Name and title of signatory, place and date (10.8.3.12; 10.8.3.13)
20 ☐ Shipper's signature (10.8.3.14)
21 ☐ 24-hour emergency response telephone number. No pagers/beepers (USG-12)

If Applicable

- 22 ☐ For special form international shipments, the special form approval certificate number in the Authorization column. A copy of the approval must be attached (10.8.3.9.4).
23 ☐ For Type B package, the design approval number in the Authorization column. For international shipments only, a copy of the approval document(s) in English, must be attached (10.8.3.9.4).
24 ☐ For Type C package, the design and shipment approval number in the Authorization column. For international shipments only, a copy of the approval document(s), in English, must be attached (10.8.3.9.4, 10.10.3.1)
25 ☐ "RQ" is written on the declaration when marked on the package (2.9.2) (USG-04). See item 36.

- 26 ☐ The words "Fissile Excepted" if the material is excepted (10.8.3.9.3)
27 ☐ For Fissile (UN 2918, UN 3324, UN 3325, UN 3326, UN 3327, UN 3328, UN 3329, UN 3330, UN 3331 or UN 3333). For Fissile material, other than fissile excepted, the Criticality Safety Index (10.8.3.9.3, step 9). Design approval and country approval certificate number in the Authorization column and copies of these approval documents are also attached (10.8.3.9.4). FedEx Legal/Radiation Physicist approval document(s) also attached. Plutonium 238, 239, and 241 not accepted as any of the fissile UN numbers listed above (FX-03).
28 ☐ If overpacked, the words "Overpack Used" (10.8.3.9.2, step 8)
29 ☐ Shipper's full signature next to amendments or alterations (10.8.1.6)

Packaging

- 30 ☐ Transportation security seal is intact (10.6.2.1.12) (Not required for industrial (IP) packages)
31 ☐ Package is in good condition, large enough, free of external damage or leakage (9.1.1.3, FX-11)

Marking

- 32 ☐ Proper shipping name (10.7.1.3.1)

- 33 ☐ UN number preceded by the prefix "UN" (10.7.1.3.1)
34 ☐ Name and address of shipper and consignee (10.7.1.3.1)
35 ☐ Package is marked USA DOT 7A Type A or Type A and country of origin. Type B and Type C packages must be marked with the design approval number and Type B or Type C (i.e., USA/9999/BIU/85 Type B) (10.7.1.3.4, 10.7.1.3.5, 10.7.1.3.6). Type IP packages must be marked Type IP-1, Type IP-2, Type IP-3 as appropriate (10.7.1.3.3).

If Applicable

- 36 ☐ "RQ" is marked on the package when on the declaration (2.9.2) (USG-04). See item 25.
37 ☐ Gross weight of the package is marked if it exceeds 50 kg (110 lb) (10.7.1.3.1).
38 ☐ When an overpack is indicated on the declaration, the statement, "Inner packages comply with prescribed specifications" appears on package (10.7.1.4.2)

Labeling

- 39 ☐ Two correctly completed radioactive labels on opposite sides (10.7.4.3.1)
40 ☐ When required, two "Cargo Aircraft Only" (Danger) labels on opposite sides, on the same surface of the package, near the hazard labels (10.7.4.2.4, 10.7.4.3.1)
41 ☐ If applicable, correct subsidiary risk labels, affixed adjacent to the primary hazard labels (10.7.3.2, 10.7.4.2.3)
42 ☐ For fissile materials, two correctly completed Criticality Safety Index (CSI) labels on opposite sides, if applicable (10.7.4.3.1)
43 ☐ Labels correctly applied and not obscured; irrelevant markings/labels covered or removed (10.7.4.1.1)

Additional Comments:

Note: DG Specialist must ensure all discrepancies are indicated before returning the shipment.

IMPORTANT: Ensure COSMOS/KIAC is updated when shipments are rejected. For further assistance, please call 1-800-Go-FedEx, (800)463-3339, then press the number "81"; to be connected to the Dangerous Goods Hotline/Hazardous Materials Hotline.

DISTRIBUTION: Yellow Copy - Return for 3 days at origin, then discard.

Effective 01/07/03

FNEX M-2139 9/03 LOGOS 139202 WCS



Dangerous Goods Acceptance Checklist — 2003



Due to the regulatory discrepancies indicated, your shipment cannot be transported by FedEx.

Tracking No. _____ Date _____
Inspected By _____ Employee Number _____

- 1 ☐ For international shipments ensure Service Reference Guide shows "D" designated locations for Express products.

- 2 ☐ Complies with all applicable government variations (2.9.2)

Shipper's Declaration—Note: The Tracking No. and the airport/city of departure and destination city may be completed by the shipper or Dangerous Goods Specialist. The declaration must have 3 copies and be typed or computer generated. (FX-12, FX-15).

- 3 ☐ Name and address of shipper (10.8.3.1)

- 4 ☐ Name and address of consignee (10.8.3.2)

- 5 ☐ Page of pages (10.8.3.4)

- 6 ☐ Correctly indicates whether packed within Passenger or Cargo Aircraft Only limitations. Must be 3.0 TI or less per package, and for medical use to be acceptable for passenger aircraft (10.8.3.5, USG10)

- 7 ☐ Non-radioactive deleted (10.8.3.8)

Nature & Quantity of Dangerous Goods — This information must be entered in the order given (10.8.3.9).

- 8 ☐ Proper shipping name (10.8.3.9.1, step 1). The following, additional PSN may be used for US domestic carriage: Radioactive Material NOS, UN 2982; Radioactive Material, Special Form, NOS, UN 2974; Radioactive Material, Fissile, NOS, UN 2918; Thorium Metal, Pyrophoric, UN 2975; Thorium Nitrate, Solid, UN 2976; Uranium Metal, Pyrophoric, UN 2979; Uranyl Nitrate Hexahydrate Solution, UN 2980; Uranyl Nitrate, Solid, UN 2981

- 9 ☐ Class number 7 (10.8.3.9.1, step 2)

- 10 ☐ UN number, preceded by prefix "UN" (10.8.3.9.1, step 3)

- 11 ☐ Packing Group number, when applicable, corresponding to subsidiary risk (10.8.3.9.1, step 4)

- 12 ☐ Subsidiary risk(s), when applicable, corresponding to subsidiary risk label(s) applied (10.8.3.9.1, step 5)

- 13 ☐ Name or symbol of radionuclide(s) (i.e., Ir-192, Mo-99) (10.8.3.9.2(a), step 6)

- 14 ☐ Description of the physical and chemical form, or "Special Form" (if not already included in Proper Shipping Name) (10.8.3.9.2(b), step 6)

- 15 ☐ Number and type of package (i.e., 1 Type A, 1 Type B, 1 IP1, 1 IP2, 1 IP3) (10.8.3.9.2, step 7)

- 16 ☐ Activity of radionuclide(s) in SI units (GBq, MBq, TBq, etc.) (10.8.3.9.2, step 7)

- 17 ☐ Category of label (i.e., White I, Yellow II or Yellow III) (10.8.3.9.3, step 9)

- 18 ☐ For Yellow II and Yellow III only, the TI to one decimal place and dimensions of the package (SI units).

- 19 ☐ Name and title of signatory, place and date (10.8.3.12; 10.8.3.13)

- 20 ☐ Shipper's signature (10.8.3.14)

- 21 ☐ 24-hour emergency response telephone number. No pagers/beepers (USG-12)

If Applicable

- 22 ☐ For special form international shipments, the special form approval certificate number in the Authorization column. A copy of the approval must be attached (10.8.3.9.4).

- 23 ☐ For Type B package, the design approval number in the Authorization column. For international shipments only, a copy of the approval document(s), in English, must be attached (10.8.3.9.4).

- 24 ☐ For Type C package, the design and shipment approval number in the Authorization column. For international shipments only, a copy of the approval document(s), in English, must be attached (10.8.3.9.4, 10.10.3.1)

- 25 ☐ "RQ" is written on the declaration when marked on the package (2.9.2) (USG-04). See item 36.

- 26 ☐ The words "Fissile Excepted" if the material is excepted (10.8.3.9.3)

- 27 ☐ For Fissile (UN 2918, UN 3324, UN 3325, UN 3326, UN 3327, UN 3328, UN 3329, UN 3330, UN 3331 or UN 3333). For Fissile material, other than fissile excepted, the Criticality Safety Index (10.8.3.9.3, step 9). Design approval and country approval certificate number in the Authorization column and copies of these approval documents are also attached (10.8.3.9.4). FedEx Legal/ Radiation Physicist approval document(s) also attached. Plutonium 238, 239, and 241 not accepted as any of the fissile UN numbers listed above (FX-03).

- 28 ☐ If overpacked, the words "Overpack Used" (10.8.3.9.2, step 8)

- 29 ☐ Shipper's full signature next to amendments or alterations (10.8.1.6)

Packaging

- 30 ☐ Transportation security seal is intact (10.6.2.1.1.2) (Not required for industrial (IP) packages)

- 31 ☐ Package is in good condition, large enough, free of external damage or leakage (9.1.1.3, FX-11)

Marking

- 32 ☐ Proper shipping name (10.7.1.3.1)

- 33 ☐ UN number preceded by the prefix "UN" (10.7.1.3.1)

- 34 ☐ Name and address of shipper and consignee (10.7.1.3.1)

- 35 ☐ Package is marked USA DOT 7A Type A or Type A and country of origin. Type B and Type C packages must be marked with the design approval number and Type B or Type C (i.e., USA9999B/UN85 Type B) (10.7.1.3.4, 10.7.1.3.5, 10.7.1.3.6). Type IP packages must be marked Type IP-1, Type IP-2, Type IP-3 as appropriate (10.7.1.3.3).

If Applicable

- 36 ☐ "RQ" is marked on the package when on the declaration (2.9.2) (USG-04). See item 25.

- 37 ☐ Gross weight of the package is marked if it exceeds 50 kg (110 lb) (10.7.1.3.1)

- 38 ☐ When an overpack is indicated on the declaration, the statement, "Inner packages comply with prescribed specifications" appears on package. (10.7.1.4.2)

Labeling

- 39 ☐ Two correctly completed radioactive labels on opposite sides (10.7.4.3.1)

- 40 ☐ When required, two "Cargo Aircraft Only" (Danger labels on opposite sides, on the same surface of the package, near the hazard labels (10.7.4.2.4, 10.7.4.3.1)

- 41 ☐ If applicable, correct subsidiary risk labels, affixed adjacent to the primary hazard labels (10.7.3.2, 10.7.4.2.3)

- 42 ☐ For fissile materials, two correctly completed Criticality Safety Index (CSI) labels on opposite sides, if applicable (10.7.4.3.1)

- 43 ☐ Labels correctly applied and not obscured; irrelevant markings/labels covered or removed (10.7.4.1.1)

Additional Comments:

Note: DG Specialist must ensure all discrepancies are indicated before returning the shipment.

For further assistance, please call 1-800-Go-FedEx® (800)463-3339, then press the number "81," to be connected to the Dangerous Goods Hotline/Hazardous Materials Hotline.

DISTRIBUTION: White Copy - Return with rejected shipment.

Effective 01/01/03

FedEx M-2139 01/03 LOGOS 39002 WCS

Guide for Preparing

SHIPPING PAPERS

One of the most frequently cited safety violations of the Hazardous Materials Regulations (HMR), Title 49 CFR Parts 100-185, is the failure of the shipper to properly describe the hazardous material on the shipping paper.

The proper shipping description of a hazardous material consists of:

- a **Basic Description**,
- additional information (depending on materials and mode of transport),
- quantity of hazardous material, and
- type of packaging used.

The **Basic Description** of a hazardous material includes the **Identification Number**, the **Proper Shipping Name**, **Hazard Class**, and **Packing Group** (when applicable). This information must be placed on the shipping paper in the specific order required in Part 172, Subpart C of the HMR. By failing to follow these requirements, shippers of hazardous materials not only put themselves at risk of being cited, but more importantly, they put others at risk should an incident or spill occur.

The HMR do not require that a shipper use a special form. The HMR only require the proper information be placed on the shipping paper in the proper sequence. Shipping papers used to describe hazardous materials may be bills of lading, invoices, manifests, or just plain papers. They may or may not have specific columns to identify the hazardous material, but when used to ship a hazardous material, they must all meet the same requirements to describe the

hazardous material using the information stated in the HMR.

When non-hazardous materials are listed on the same shipping paper with hazardous materials, the hazardous materials must be listed first, or be entered in a clearly contrasting color, or highlighted in a contrasting color to distinguish them from non-hazardous materials. Alternatively, when a shipping paper has a column captioned "HM" for "hazardous materials" the letter "X" may be placed in that column, indicating the description that follows identifies a hazardous material.

Consistent with the requirements of the HMR, this Guide: (1) explains the shipping paper requirements, (2) provides examples of shipping paper entries and formats, including the emergency response telephone number, (3) provides guidance regarding emergency response information, and (4) general procedures for retaining shipping papers. Section 172.200 may be checked to identify instances when shipping papers are not required.

Throughout this Guide we have used "**bold**" characters to assist you in identifying the information that is required for the **Basic Description**. We also use the acronym "**ISHP**" to assist you in remembering the components of the **Basic Description**.

NOTE: This document is for general guidance only and must not be used to determine compliance with 49 CFR, Parts 100-185.

1

SHIPPING PAPER CHECKLIST

You should always check the HMR, Part 172, Subpart C, for specific Shipping paper requirements that may pertain to the materials you are shipping.

Use the following as a guide. Additional information may be required.

Shipping Description (§172.202)

Use the acronym "ISHP" to assist in remembering the proper sequence of the **Basic Description**

Basic Description (proper sequence §172.202(b))

Use the Hazardous Materials Table (HMT) (§172.101)

- I** ☐ Identification Number (HMT Column 4)
- S** ☐ Proper Shipping Name (HMT Column 2)
- H** ☐ Hazard Class (HMT Column 3)
- P** ☐ Packing Group (HMT Column 5)

Other Information (§172.202)

- ① ☐ Technical name ("G" in HMT Column 1). See HMR §172.203(k) for specific requirements.
- ② ☐ Subsidiary hazard(s) (HMT Column 6)
- ③ ☐ Number and type of packages (i.e., "12 drums" or "12 1A1 drums")
- ④ ☐ Total quantity (by mass or volume, i.e., "200 kgs" or "50 L")
- ⑤ ☐ "Net Explosive Mass" for Class 1. See HMR §172.202(a)(5)(i) for specific requirements.
- ⑥ ☐ "EX-xxx" for Class 1 materials when not marked on the package. See HMR §172.320(d) for specific requirements.

CONVERSION TABLE

1 lb = .454 kg; 1 gal = 3.785 L

Additional Descriptions – as applicable (§172.203)

- ☐ "DOT-SPxxxx" or "DOT-Exxxxx" Special Permit or Exemption number
- ☐ "Ltd Qty" or "Limited Quantity"
- ⑦ ☐ "RQ" for Reportable Quantity. See Appendix A of the HMT for specific requirements.
- ☐ "RESIDUE: LAST CONTAINED****" (Required for tank car with residue)
- ⑧ ☐ "Marine Pollutant" (for non-bulk by vessel and bulk in all modes). See Appendix B of the HMT for specific requirements.
- ⑨ ☐ "Poison-Inhalation Hazard" or "Toxic-Inhalation Hazard" and applicable Zone, e.g., "Zone A", "Zone B", etc., (HMT Column 7 and §172.102)
- ☐ "HOT" for liquid elevated temperature materials, when molten or elevated temperature is not part of proper shipping name. See HMR §172.203(n) for specific requirements.
- ☐ "Organic Peroxides" See HMR §172.203(o) for specific requirements.
- ☐ "Waste" See HMR §171.101(c)(9) for specific requirements.
- ☐ "Radioactive Material" See HMR §172.203(d) for specific requirements.
- ⑩ ☐ Mode Requirements - Additional information may be required depending on specific mode(s) of transport. See HMR §172.203 for specific requirements.

Emergency Response Telephone Number (§172.201(d), §172.604)

- ⑪ ☐ "EMERGENCY CONTACT: xxx-xxx-xxxx" (include international access code if applicable).

Shipper's Certification (§172.204)

- ⑫ ☐ Signed statement: "This is to certify that the above-mentioned materials..." See HMR §172.204 for specific certification statements.

2

§172.101 HAZARDOUS MATERIALS TABLE EXCERPTS

Symbols (1)	Hazardous Materials Descriptions and Proper Shipping Names (2)	Hazard Class or Division (3)	Identification Numbers (4)	PG (5)	Label Codes (6)	Special Provisions (§172.102) (7)	(8) Packaging (§173.**)			(9) Quantity Limitations	
							Exceptions (8A)	Non-bulk (8B)	Bulk (8C)	Passenger aircraft only (9A)	Cargo aircraft only (9B)
	Acrolein, stabilized	6.1	UN1092	I	6.1, 3	1, B9, B14, B30, B42, B72, B77, T22, TP2, TP7, TP10, TP38, TP44	None	226	244	Forbidden	Forbidden
	Copper cyanide	6.1	UN1587	II	6.1	IB8, IP2, IP4 T3, TP33	153	204	242	25kg	100kg
G	Flammable liquids, n.o.s.	3	UN1993	I	3	T11, TP1, TP27	150	201	243	1L	30L
				II	3	IB2, T7, TP1, TP8, TP28	150	202	242	5L	60L
				III	3	B1, B62, IB3, T4, TP1, TP29	150	203	242	60L	220L
	Phosphoric acid solution	8	UN1805	III	8	A7, IB3, N34, T4, TP1	154	203	241	5L	60L

SHIPPING DESCRIPTIONS

Hazardous and Non-hazardous Materials*

No. of Units & Container Type (3)	HM	BASIC DESCRIPTION Identification Number (UN or NA), Proper Shipping Name, Hazard Class, Packing Group, per 172.101, 172.202, 172.203	TOTAL QUANTITY (Weight, Volume, Gallons, etc.) (4)
1 Box		Carriage Bolts	1000
4 Drums	X	UN1805, Phosphoric acid solution, 8, PGIII	4 gal
2 Drums	X	UN1993, Flammable liquids, n.o.s. (contains methanol), 3, PGIII	100 gal
		(1)	
		(10) This shipment is within limitations for cargo aircraft only.	

*When not listed first, use a contrasting color or highlight the Basic Description, and/or place an "X" in the "HM" column when provided.

Toxic Inhalation and Subsidiary Risk

No. of Units & Container Type (3)	BASIC DESCRIPTION Identification Number (UN or NA), Proper Shipping Name, Hazard Class, Packing Group, per 172.101, 172.202, 172.203	TOTAL QUANTITY (Weight, Volume, Gallons, etc.) (4)
10 drums	UN1092, Acrolein, stabilized, 6.1(3), PGI, Toxic-Inhalation Hazard, Zone A (9)	1 gal

Reportable Quantity and Marine Pollutant

No. of Units & Container Type (3)	HM	BASIC DESCRIPTION Identification Number (UN or NA), Proper Shipping Name, Hazard Class, Packing Group, per 172.101, 172.202, 172.203	TOTAL QUANTITY (Weight, Volume, Gallons, etc.) (4)
1 Box	X	RQ, UN1586, Copper Cyanide, 6.1, PGIII, Marine Pollutant, 800-555-1234	10 lbs
		(7) (8) OR (11)	
1 Box	RQ	UN1586, Copper Cyanide, 6.1, PGIII, Marine Pollutant, 800-555-1234	10 lbs
		(8) (11)	

Explosives

No. of Units & Container Type (3)	BASIC DESCRIPTION Identification Number (UN or NA), Proper Shipping Name, Hazard Class, Packing Group, per 172.101, 172.202, 172.203	TOTAL QUANTITY (Weight, Volume, Gallons, etc.) (4)
1 Box	UN0030, Detonators, electric, 1.1B, PGII, EX-number (as applicable) (6)	.008 Net Explosive Mass

3

Hazardous Materials Table

The first step in filling out a shipping paper correctly is to look in the Hazardous Materials Table (HMT) §172.101, and find the entry that most appropriately describes the material you are shipping. Information used to describe a hazardous material on a shipping paper is known as the **Basic Description**. Information for the Basic Description consists of the **Identification Number** in Column 4; the **Proper Shipping Name** in Column 2; the **Hazard Class or Division** in Column 3; and the **Packing Group** in Column 5. If a material has one or more subsidiary hazards, they are identified in Column 6. Subsidiary hazards must also be listed with the Basic Description. By using the information provided in the HMT, you can correctly describe the hazardous materials shipment.

Columns 1 and 7 provide codes that may indicate additional information about the material you are shipping. For example, a "G" in Column 1 indicates that the Proper Shipping Name listed must be further identified by the addition of a "technical name" placed in parentheses. The chemical manufacturer or the material safety data sheet should provide this information.

Special provision codes listed in Column 7 are defined in §172.102. They may identify additional information about the material that may be required to be entered in addition to the Basic Description.

Once you have identified the material in the HMT, the process is not yet complete. Appendix A and Appendix B to the HMT must also be checked. Appendix A is a List of Hazardous Substances and Reportable Quantities (RQ). If the material is listed in Appendix A, you must determine if it meets the definition of the hazardous substance prescribed in §171.8. If it does, and the quantity per package meets or exceeds the amount listed, an additional step must be taken to identify it as a reportable quantity on the shipping paper. (See HMR §172.203 for specific requirements.)

Appendix B is a list of Marine Pollutants. When shipping non-bulk packages and a hazardous material meets the definition of a marine pollutant, it must be identified as a marine pollutant if any portion of transportation is by vessel. A marine pollutant in bulk packages must be identified on the shipping papers when transported by any mode. (See HMR §172.203(l) for specific requirements.)

Shipping Description

A correct shipping description includes many components, including the Basic Description. The **Basic Description** must be placed on a shipping paper in the sequence called for in §172.202(b) of the HMR. An easy way to remember the sequence is to use the acronym "**ISHP**": **I**dentification Number, **S**hipping Name, **H**azard Class or Division, and **P**acking Group.

If a technical name is required, it must be placed in parentheses and may be listed after the Proper Shipping Name or after the Basic Description. If applicable, a subsidiary

hazard class(es) must be placed in parentheses immediately following the primary hazard class.

The total amount of hazardous materials covered by each description must be indicated by mass or volume with the applicable unit of measure. For example: "200 kgs" or "50 L". The number and type of packages must also be indicated and may include the packaging specification, for example: "12 drums," "12 1H1 drums," or "12 drums (UN 1A1)." The total quantity and types of packagings may be entered before or after the Basic Description or both before and after the Basic Description.

Additional Description

When additional information is required or provided it must be listed after the Basic Description, unless the HMR states otherwise. Looking at the "Check List" in this guide, you will see many of these identified under Additional Descriptions. Always check §172.203 of the HMR to ensure you have identified all the requirements that pertain to your shipment.

Two exceptions to the regulation for placing additional information after the Basic Description pertain to the "Technical name" and the letters "RQ". The "Technical name" may be placed in parentheses after

the Proper Shipping Name or after the Basic Description. The "RQ" may be entered either before or after the Basic Description. On a shipping paper that has a column specifically to identify a hazardous material, the "RQ" may replace the "X" that would normally be placed in that column.

Some hazardous materials, such as radioactive materials, require much more specific information than what is covered here. Always use Part 172, Subpart C of the HMR for specific details and other information that may pertain to your shipment.

SAMPLE SHIPPING PAPER

STRAIGHT BILL OF LADING
ORIGINAL NOT NEGOTIABLE

Shipper No. _____
Carrier No. _____
Date _____

Page _____ of _____ (Name of carrier) (b3)(C)(i)

TO: _____
Consignee _____
Street _____
City _____ State _____ Zip Code _____
City _____ State _____ Zip Code _____

FROM: _____
Shipper _____
Street _____
City _____ State _____ Zip Code _____

City _____ State _____ Zip Code _____

IN No. Emergency Contact Tel. No. **800-555-1234**

Route _____

No. of Units & Container Type	HM	BASIC DESCRIPTION Proper Shipping Name, Hazard Class, Identification Number (UN or NA), Packing Group, per 172.101, 172.202, 172.203	TOTAL QUANTITY (Gross, Volume, Gallons, etc.)	WEIGHT (Gross, Volume, Gallons, etc.)	RATE	CHARGES (Per Carrier Use Only)
③ 4 Drums	X	I S H P ④ UN1805, Phosphoric acid solution, 8, PGIII	4 gal			
		OR				
4 Drums	X	S H I P Phosphoric acid solution, 8, UN1805, PGIII	4 gal			

PLACARDS TENDERED: YES ☐ NO ☐

Notes: (1) Where the law is dependent on value, shippers are required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (2) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (3) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (4) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (5) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (6) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (7) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (8) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (9) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (10) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (11) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

Notes: (12) Where the shipper is not required to specify in writing the agreed or declared value of the property, as follows: The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____.

SHIPPER _____
PER _____
DATE _____

CARRIER _____
PER _____
DATE _____

Permanent post-office address of shipper _____

Shipper's Certification

Except as provided in the HMR, each person who offers a hazardous material for transportation shall certify the shipment is offered in accordance with the HMR. Several options for certification statements are listed in §172.204. Specific statements are required for air shipments. The following is an example of one certification statement: "This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation

according to the applicable regulations of the Department of Transportation." These certifications must be signed by a principal, officer, partner, or employee of the shipper or his agent. They may be signed manually, by typewriter, or by other mechanical means.

5

Retention

The person who provides the shipping paper shall record the date the hazardous material is accepted by the carrier (this may vary for rail, vessel or air) and maintain a copy or electronic image of this shipping paper for two years from that date. The copies must be accessible at or

through the principal place of business and must be made available if requested by an authorized official of a Federal, State, or local government agency at reasonable times and locations. See HMR §172.201 for specific requirements.

Emergency Response Telephone Number

Shipping papers must contain an emergency response telephone number unless specifically excepted as provided in HMR §172.604(c). The emergency response telephone number must include the area code or international access code. The number provided is used in case of an emergency involving the hazardous material. The number must be monitored at all times while the material is in transportation or in storage incidental to transportation. The person monitoring the number must be knowledgeable of the hazardous material being shipped and have information that will assist first responders at the scene of an incident involving the hazardous material; e.g., fire or explosion hazards, protective clothing required, evacuation distance. If not knowledgeable, the person answering must have immediate access to a person who has that knowledge. An answering service, answering machine, or beeper does not meet these requirements.

The emergency response telephone number may be entered after the shipping description or it may be located in a designated area on the shipping paper that is clearly visible and easily identified, for example: "EMERGENCY CONTACT: xxx-xxx-xxxx." If the number is placed in one location, that number must apply to all the hazardous materials described on the shipping paper. If different emergency numbers are needed for individual descriptions, the correct emergency response number must be entered after the proper shipping description it applies to. The telephone number may be the number of the person offering the shipment as long as that person monitors it as required above. If the number of an agency or organization is listed, the person offering the shipment must ensure the agency has received the most current information on the material and that it accepts responsibility for providing this information in an emergency. Many agencies require a fee to provide this service.

Emergency Response Information

The HMR require that a shipment of hazardous materials include "emergency response information" which may be on the shipping paper itself or attached to the shipping paper. This emergency response information can be used in the event of an incident involving hazardous materials to assist emergency responders in responding at the scene. At a minimum this information must include: (1) the Basic Description

(including technical name, if applicable), (2) immediate hazards to health, (3) risks of fire or explosion, (4) immediate precautions to be taken in event of an accident or incident, (5) immediate methods for handling fires, (6) initial methods for handling spills or leaks in the absence of fire, and (7) preliminary first aid measures. For additional and specific requirements, you should check Part 172, Subpart G of the HMR.



U.S. Department
of Transportation
**Pipeline and
Hazardous Materials
Safety Administration**
<http://hazmat.dot.gov>



PHH50-0086-1206

Emergency Procedures

In the event an accident would occur involving radioactive material during transport, the following procedures shall be followed:

1. Immediately clear the area of individuals to avoid contamination and maintain surveillance of the area.
2. Notify the Radiation Safety Officer () at the following numbers:

Work
Home
Cell
3. If not available, notify at the following numbers:

Work
Home
Cell
4. Notify other authorities as needed. Radiation Safety Officer or will contact the state regulatory agency, if needed.
5. Maintain surveillance of the area until assistance arrives and the area is cleaned.
6. A copy of this procedure must be maintained in the vehicle during transport of radioactive material.

Emergency Procedures

Potential Hazards

Health Hazards

External radiation hazard from unshielded radioactive material.
Internal radiation hazard from inhalation, ingestion, or breaks in skin.
Radioactive material; degree of hazards will vary greatly, depending on type and quantity of radioactive material and type of packaging.
Materials in Special Form or in Type B packaging are not expected to cause contamination in accidents.
Commonly available instruments cannot detect some radioactive materials. Runoff from fire control or dilution water may cause pollution.

Fire or Explosion

Some of these materials may burn, but none of them ignites readily.
Radioactivity does not change flammability or other properties of the materials.

Emergency Action

Keep unnecessary people clear and upwind of spill; greater distances may be necessary for people downwind, or is advised by Radiation Authority.
Isolate hazard area and deny entry.
Response actions may be performed before any measurement of radiation; limit entry to shortest possible time.
Positive pressure self-contained breathing apparatus (SCBA) and structural firefighters' protective clothing will provide limited protection.
Notify Radiation Authority of accident conditions.
Detain uninjured persons, isolate equipment with suspected contamination, and delay clean up until instruction of Radiation Authority.

If water pollution occurs, notify the appropriate authorities.

Fire

Do not move damaged containers; move undamaged containers out of fire zone.
Small Fires: Dry chemical, CO₂, water spray, or regular foam
Large Fires: Water spray, fog (flooding amounts)
For massive fire in cargo area, use unmanned hose holder or monitor nozzles.

Spill or Leak

Do not touch damaged containers or spilled material

Damage to outer container may not affect primary inner container.

Small Liquid Spills: Take up with sand, earth, or other noncombustible absorbent material.

Large Liquid Spills: Dike far ahead to collect runoff water.

First Aid

Use first aid treatment according to nature of the injury.
If not affecting injury, remove and isolate suspected contaminated clothing and shoes; wrap victim in sheet or blanket before transporting.
If there is no injury, remove and isolate suspected contaminated clothing and shoes; assist person to shower with soap and water and notify Radiation Authority of action.
Advise medical personnel that victim may be contaminated with radioactive material.

HAZARDOUS MATERIALS TRANSPORTATION ENHANCED SECURITY REQUIREMENTS



U.S. Department of Transportation
Research and Special Programs
Administration

Hazardous Materials Transportation Enhanced Security Requirements

September 11, 2001, brought home the reality of terrorism to all Americans. The terrible events of that day and the later anthrax scare, along with earlier bombings at the World Trade Center in 1993 and in Oklahoma City in 1995, mean that we all need to play our part in combating terrorism in order to maintain the type of lifestyle we enjoy.

The Department of Transportation's Research and Special Programs Administration (RSPA) is responsible for the safe and secure transportation of hazardous materials. Hazardous materials are essential to the economy of the United States and the well-being of its people. Hazardous materials fuel our cars and trucks and heat and cool our homes and offices.

Hazardous materials are used in farming and medical applications and in manufacturing, mining, and other industries. Every day millions of tons of hazardous materials are safely transported by plane, train, truck, or vessel in quantities ranging from several ounces to thousands of gallons. In the wrong hands, however, hazardous materials can pose a significant security threat, particularly those that can be used as weapons of mass destruction. Addressing this security threat is vital to our citizens and our economy.

Since September 11, 2001, RSPA has worked closely with hazardous materials shippers and carriers, as well as Federal, state, and local government agencies, to improve the security of hazardous materials in our Nation's transportation system. The hazardous materials industry can do a lot to improve hazardous materials transportation security. The information presented on the following pages is intended to encourage you to include security considerations in all of your operations and to assist you in managing the potential security risks associated with the transportation of hazardous materials.

There are two strategies that are critical to managing transportation security risks. The first is to develop and implement security plans. The second is to assure that employees who handle and transport hazardous materials are trained to recognize and react to potential security problems. RSPA has established new security requirements that make use of these two strategies for hazardous materials transported in commerce.



Security Plans

You must develop and implement a security plan if you offer for transportation or transport the following types or quantities of hazardous materials:

- A hazardous material in an amount that must be placarded in accordance with the Hazardous Materials Regulations;
- A hazardous material in a bulk packaging having a capacity equal to or greater than 13,248 L (3,500 gallons) for liquids or gases or more than 13.24 cubic meters (468 cubic feet) for solids; or
- A select agent or toxin regulated by the Centers for Disease Control and Prevention under 42 CFR part 73.

At a minimum, your security plan must include the following elements:

- Personnel security;
- Unauthorized access; and
- En route security.

Your security plan must be in writing and must be retained for as long as it remains in effect. Your security plan must be revised as necessary to reflect changing circumstances.

Training

You must provide training to your employees who are responsible for implementing your security plan. This training should cover the following topics:

- Company security objectives;
- Specific security procedures;
- Employee responsibilities;
- Actions to take in the event of a security breach; and
- Organizational security structure.

In addition, all hazmat employees – that is, employees who directly affect hazardous materials transportation safety – must receive training that provides an awareness of the security risks associated with hazardous materials transportation and methods to enhance transportation security. This training should also include a component that covers how to recognize and respond to possible security threats.



The following guidance should assist you in developing a security plan appropriate to your industry and operations. Even if you are not covered by the security plan requirements in the Hazardous Materials Regulations, you may want to review your current security program and make any necessary adjustments to improve it.

Begin with a Security Assessment

To develop a security plan, you should begin with a security assessment. List the materials you handle and identify those with the potential for use as a weapon or target of opportunity. Then, review your current activities and operations from a transportation security perspective. Ask yourself, **“What are we doing now? What could go wrong? What can we do differently?”** You can use a security risk assessment model to identify security risks and develop appropriate measures to reduce or eliminate those risks. The Risk Management Self-Evaluation Framework



Security Template found on RSPA's hazmat safety homepage (<http://hazmat.dot.gov>) utilizes the following steps:

- **Scoping** – determine the scope of operations that should be subject to security risk management. Identify the types of hazardous materials you handle and the modes of shipment used.
- **Knowledge of operations** – collect detailed information about your transportation operations: (1) quantities of material transported; (2) baseline security programs; (3) current security procedures; and (4) related safety programs and procedures.
- **Assessment** – analyze potential security threats and identify security risk control points. Risk control points are points in the transportation process where you can make an impact by improving procedures or operations.
- **Strategy** – rank or group security risks, prioritize opportunities for security risk reduction, and decide on preventative actions. Create a written document summarizing your decisions. This written document is your security plan.
- **Action** – implement your security plan.
- **Verification** – monitor implementation of your security plan.
- **Evaluation** – determine if goals are being met and compare your strategy and results with others in your field.



Suggested Security Measures

The following are specific security measures that you may want to consider for inclusion in your security plan.

At a minimum, a security plan must include the following elements: personnel security, unauthorized access, and en route security.

Personnel Security

Be aware of the possibility that someone you hire may pose a potential security risk. Establish a process to confirm the information provided by applicants on application forms or resumes, including checking with former and current employers, and personal references provided by job applicants. Such confirmation must be consistent with applicable Federal and State laws and requirements concerning employment practices and individual privacy.

Your employees, however, can be one of your most critical assets as you endeavor to improve the security of your shipping or transportation operations. Under the new RSPA security requirements, you must ensure your employees are familiar with your security plan and are properly trained in its implementation. Training should include company security objectives, specific security procedures, employee responsibilities, and organizational security structure. In addition, consider taking one or more of the following actions:

- Encourage your employees to report suspicious incidents or events.
- Implement routine security inspections.
- Convene regular employee/management meetings on security measures and awareness.



- Communicate with your staff using an internal communication system to provide information on facts, trends, and other security issues. Because Internet communications may be accessed by others, consider alternative methods for communicating sensitive information.

Unauthorized Access

Access to hazardous materials in transportation and to your facility should be another security concern. Consider utilizing one or more of the following security measures to prevent unauthorized access:

- Establish partnerships with local law enforcement officials, emergency responders, and other public safety agencies with jurisdiction over your facility. Through such relationships, you can exchange information about threats, trends, and unsuccessful security programs.
- Request a review of your facility and security program by local law enforcement and fire safety officials.
- Restrict the availability of information related to your facility and the materials you handle. Encourage authorities in possession of information about your facility to limit disclosure of that information to a need-to-know basis.
- Add security guards and increase off-hour patrols by private security personnel. Request that law enforcement personnel increase off-hour patrols.
- Check the adequacy of locks and other protective equipment. Consider equipping access gates with timed closure devices. Conduct frequent inspections.



- Install additional lights, alarm systems, or surveillance cameras.
- Restrict access to a single entry or gate.
- Place limits on visitor access, especially when the Homeland Security Alert System raises its threat level; require visitors to register and show photo identification, and have someone accompany visitors at all times.
- Require employees to display identification cards or badges.
- Conduct security spot checks of personnel and vehicles.
- Upgrade security procedures for handling pick-ups and deliveries at your facilities. Verify all paperwork and require pick-ups and deliveries be handled only by appointment with known vendors. Require that vendors call before a delivery and provide the driver's name and vehicle number. Accept packages and deliveries only at the facility front gate.
- Secure hazardous materials in locked buildings or fenced areas. Have a sign-out system for keys.
- Secure valves, manways, and other fixtures on transportation equipment when not in use. Lock all vehicle and delivery trailer



doors when not in use. Secure all rail, truck, and intermodal containers when stored at your location.

- Use tamper-resistant or tamper-evident seals and locks on cargo compartment openings.
- Periodically inventory the quantity of hazardous materials you have on site in order to recognize if a theft has occurred.
- Keep records of security incidents. Review records to identify trends and potential vulnerabilities.
- Report any suspicious incidents or individuals to your local Federal Bureau of Investigation (FBI) office and to local law enforcement officials.

En Route Security

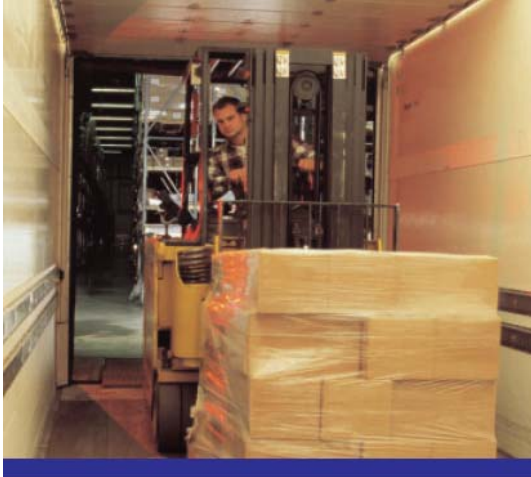
Shippers and carriers should work together to assure the security of hazardous materials shipments en route from origin to destination. Shippers should assess the security of transportation modes or combinations of modes available for transporting specific materials and select the most appropriate method of transportation to ensure their efficient and secure movement.

Know your carrier and have a system for qualifying the carriers used to transport



hazardous materials. Consider implementing one or more of the following measures:

- Use carrier safety ratings, assessments, safety surveys, or audits, and ask the carrier to provide information on security measures it has implemented.
- Verify the carrier has an appropriate employee hiring and review process, including background checks, and an ongoing security training program.
- Verify the identity of the carrier and/or driver prior to loading a hazardous material.
- Ask the driver for photo identification and a commercial drivers license for comparison with information provided by the carrier.
- Ask the driver to tell you the name of the consignee and the destination for the material and confirm with your records before releasing shipments.
- Identify preferred and alternative routing, including acceptable deviations.
- Strive to minimize product exposures to communities or populated areas, including downtown areas; avoid tunnels and bridges



where possible; and expedite transportation of the shipment to its final destination.

- Minimize stops en route; if you must stop, select locations with adequate lighting on well-traveled roads, and check your vehicle after each stop to make sure nothing has been tampered with.
- Consider using two drivers or driver relays to minimize stops during the trip. Avoid layovers, particularly for high hazard materials.
- Shippers and rail carriers should cooperate to assure the security of rail cars stored temporarily on leased tracks.
- If materials must be stored during transportation, make sure they are stored in secure facilities.
- Train drivers in how to avoid high jacking or stolen cargo - keep vehicles locked when parked and avoid casual conversations with strangers about cargoes and routes.
- Consider whether a guard or escort for a specific shipment of hazardous material is appropriate.

- Consider using advanced technology to track or protect shipments en route to their destinations. For example, you may wish to install tractor and trailer anti-theft devices or use satellite tracking or surveillance systems. As an alternative, consider frequent checks with drivers by cell phone to ensure everything is in order.
- Install tamper-proof seals on all valves and package or container openings.
- Establish a communication system with transport vehicles and operators, including a crisis communication system with primary and back-up means of communication among the shipper, carrier, and law enforcement and emergency response officials.
- Implement a system for a customer to alert the shipper if a hazardous materials shipment is not received when expected.
- When products are delivered, check the carrier's identity with shipping documents provided by the shipper.
- Get to know your customers and their hazardous materials programs. If you suspect you have shipped or delivered a hazardous material to someone who may intend to use it for a criminal purpose, notify your local FBI office or local law enforcement officials.
- Report any suspicious incidents or individuals to your local FBI office and to local law enforcement officials.



Additional Information

Up-to-date information is a key element of any security plan. You should consider methods to:

- Gather as much data as you can about your own operations and those of other businesses with similar product lines and transportation patterns;
- Develop a communications network to share best practices and lessons learned;
- Share information on security incidents to determine if there is a pattern of activities that, when considered in isolation are not significant, but when taken as a whole generate concern; and
- Revise your security plans as necessary to take into account changing circumstances and new information.

CONTACTS

Federal Agencies

Research and Special Programs Administration
U.S. Department of Transportation
400 Seventh Street, SW., Washington, DC 20590
Hazardous Materials Info-Line: 800 467-4922;
<http://hazmat.dot.gov/>

Publications and Reports
Fax: 202-366-7342; E-mail: training@rspa.dot.gov
Telephone: 202-366-2301

Federal Motor Carrier Safety Administration
U.S. Department of Transportation
400 7th Street, SW., Washington, DC 20590
Telephone: 202-366-2519, www.fmcsa.dot.gov

Federal Railroad Administration
U.S. Department of Transportation
1120 Vermont Avenue, NW., Washington, DC 20590
www.fra.dot.gov

Transportation Security Administration
601 12th Street, South
Arlington, Virginia 22202
Telephone: 866-289-9673, www.tsa.gov

United States Coast Guard
2100 Second Street, SW., Washington, DC 20593
Telephone: 202-267-2229, www.uscg.mil

Industry Associations/Organizations

American Chemistry Council
1300 Wilson Boulevard, Arlington, Virginia 22209
Telephone: 703-741-5000, www.americanchemistry.com

American Petroleum Institute
1220 L Street, NW., Washington, DC 20005
Telephone: 202-682-8000, www.api.org

American Society for Industrial Security
1625 Prince Street, Alexandria, Virginia, 22314
Telephone: 703-519-6200, www.asisonline.org

American Trucking Associations
2200 Mill Road, Alexandria, Virginia 22314
Telephone: 703-838-1700, www.truckline.com

Association of American Railroads
50 F Street, NW., Washington, DC 20001-1564
Telephone: 202-639-2100, www.aar.org



Center for Chemical Process Safety, American Institute of Chemical Engineers

3 Park Avenue, New York, N.Y. 10016-5991
Telephone: 212-591-7319, www.aiche.org/ccps

Chlorine Institute

2001 L Street, Suite 506, NW., Washington, DC 20036
Telephone: 202-775-2790, www.ci2.com

Compressed Gas Association

4221 Walney Road, 5th Floor Chantilly, Virginia 20151
Telephone: 703-788-2700, www.cganet.com

The Fertilizer Institute

Union Center Plaza, Suite 430, 820 First Street, NE.,
Washington, DC 20002, Telephone: 202-962-0490, www.tfi.org

Institute of Makers of Explosives

1120 19th Street, Suite 310, NW., Washington, DC 20036
Telephone: 202-429-9280, www.ime.org

National Association of Chemical Distributors

1560 Wilson Boulevard, Suite 1250, Arlington, Virginia 22209
Telephone: 703-527-6223, www.nacd.com

National Propane Gas Association

600 Eisenhower Lane, Suite 100, Lisle, Illinois 60532
Telephone: 630-515-0600, www.npga.org

National Tank Truck Carriers

2200 Mill Road, Alexandria, Virginia 22314
Telephone: 703-838-1960, www.tanktransport.com

Security Industry Association

635 Slaters Lane, Alexandria, Virginia 22314, www.siaonline.org

Synthetic Organic Chemical Manufacturers Association

1850 M Street, NW, Suite 700, Washington, DC 20036
Telephone: 202-721-4100, www.socma.com

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