

From 49 CFR

Subpart I

RADIOACTIVE MATERIALS

Sec. 173.401 Scope. (a) This subpart sets forth requirements for the transportation of radioactive materials by carriers and shippers subject to this subchapter. The requirements prescribed in this subpart are in addition to, but not in lieu of, other requirements set forth in this subchapter and in 10 CFR Part 71 for the packaging and transportation of radioactive materials.

(b) This subpart does not apply to:

(1) Radioactive materials produced, used, transported, or stored within an establishment other than during the course of transportation.

(2) Radioactive materials contained in a medical device, such as a heart pacemaker, which is implanted in a human being or live animal.

(3) Radiopharmaceuticals that have been injected into, or ingested by, and are still in human beings or live animals.

Sec. 173.403 Definitions. In this subpart:

(a) "A₁" means the maximum activity of special form radioactive material permitted in a Type A package.

(b) "A₂" means the maximum activity of radioactive material,

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other than special form or low specific activity radioactive material, permitted in a Type A package. These values are either listed in § 173.435 or may be derived in accordance with the procedure prescribed in § 173.433.

(c) "Closed transport vehicle" means a transport vehicle equipped with a securely attached exterior enclosure that during normal transportation restricts the access of unauthorized persons to the cargo space containing the radioactive 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 ends.

(d) "Containment system" means the components of the packaging intended to retain the radioactive contents during transportation.

(e) "Conveyance" means:

(1) For transport by public highway or rail: any transport vehicle or large freight container;

(2) For transport by vessel: any vessel, or any hold, compartment, or defined deck area of a vessel; and

(3) For transport by aircraft: any aircraft.

(f) "Depleted uranium" means uranium containing less uranium-235 than the naturally occurring distribution of uranium isotopes.

(g) "Design" means the description of a special form material, a package, or a packaging, 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.

(h) "Enriched uranium" means uranium containing more uranium-235 than the naturally occurring distribution of uranium isotopes.

(i) "Exclusive use" (also referred to in other regulations as "sole use" or "full load") means the sole use of a conveyance by a single consignor and for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee. Any loading or unloading must be performed by personnel having radiological training and resources appropriate for safe handling of the consignment. Specific instructions for maintenance of exclusive use shipment controls must be issued in writing and included with the shipping paper information provided to the carrier by the consignor.

(j) "Fissile material" means any material consisting of or containing one or more fissile radionuclides. Fissile radionuclides are plutonium-238, plutonium-239, plutonium-241, uranium-233 and uranium-235. Neither natural nor depleted uranium are fissile material. Fissile materials are classified according to the controls needed to provide nuclear criticality safety during transportation, as provided in § 173.455. Certain exclusions are provided in § 173.453.

(k) "Freight container" means a reusable container having a volume of 1.81 cubic meters (64 cubic feet) or more, designed and constructed to permit 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 are designated as "large freight containers."

(l) "Highway route controlled quantity" means a quantity within a single package which exceeds:

(1) 3000 times the A_1 value of the radionuclides as specified in § 173.433 for special form radioactive material;

(2) 3000 times the A_2 value of the radionuclides as specified in § 173.433 for normal form radioactive material; or

(3) 30,000 curies, whichever is least.

(m) "Limited quantity of radioactive material" means a quantity of radioactive material not exceeding the materials package limits specified in § 173.423 and which conform with requirements specified in § 173.421.

(n) "Low specific activity material (LSA)" means any of the following:

(1) Uranium or thorium ores and physical or chemical concentrates of those ores.

(2) Unirradiated natural or depleted uranium or unirradiated natural thorium.

(3) Tritium oxide in aqueous solutions provided the concentration does not exceed 5.0 millicuries per milliliter.

(4) Material in which the radioactivity is essential uniformly distributed and in which the estimated average concentration of contents does not exceed:

(i) 0.0001 millicurie per gram of radionuclides for which the A_2 quantity is not more than .05 curie;

(ii) 0.005 millicurie per gram of radionuclides for which the A_2 quantity is more than .05 curie, but not more than 1 curie; or

(iii) 0.3 millicurie per gram of radionuclides for which the A_2 quantity is more than 1 curie.

(5) Objects of nonradioactive material externally contaminated with radioactive material, provided that the radioactive material is not readily dispersible and the surface contamination, when averaged over an area of 1 square meter, does not exceed 0.0001 millicurie (220,000 disintegrations per minute) per square centimeter of radionuclides for which the A_2 quantity is not more than .05 curie, or 0.001 millicurie (2,200,000 disintegrations per minute) per square centimeter for other radionuclides.

(o) "Multilateral approval" means approval by both the appropriate competent authority of the country of origin and of each country through or into which the shipment is to be transported. This definition does not imply approval from countries over which radioactive materials are carried in aircraft, if there is no scheduled stop in that country.

(p) "Natural thorium" means thorium with the naturally occurring distribution of thorium isotopes (essentially 100 weight percent thorium-232).

(q) "Natural uranium" means uranium with the naturally occurring distribution of uranium isotopes (approximately 0.711 weight percent uranium-235 and the remainder essentially uranium-238).

(r) "Non-fixed radioactive contamination" means 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.

(s) "Normal form radioactive material" means radioactive material which has not been demonstrated to qualify as "special form radioactive material."

(t) "Package" means, for radioactive materials, the packaging together with its radioactive contents as presented for transport.

(u) "Packaging" means, for 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, 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.

(v) "Radiation level" means the radiation dose-equivalent rate expressed in millirem per hour (mrem/h). Neutron flux densities may be converted into radiation levels according to Table 1:

TABLE 1.—NEUTRON FLUX DENSITIES TO BE REGARDED AS EQUIVALENT TO A RADIATION LEVEL OF 1 MILLIREM PER HOUR (MREM/H)¹

Energy of neutron	Flux density equivalent to 1 mrem/h (Neutrons per square centimeter per second) (n/cm ² /s)
Thermal	268.0
5 keV	228.0
20 keV	112.0
100 keV	32.0
500 keV	12.0
1 MeV	7.2
5 MeV	7.2
10 MeV	6.8

¹ Flux densities equivalent for energies between those listed above may be obtained by linear interpolation.

(w) "Radioactive article" means any manufactured instruments and articles such as an instrument, clock, electronic tube or apparatus, or similar instruments and articles having radioactive material as a component part.

(x) "Radioactive contents" means the radioactive material, together with any contaminated liquids or gases, within the package.

(y) "Radioactive material" means any material having a specific activity greater than 0.002 microcuries per gram (uCi/g) (see definition of "specific activity").

(z) "Special form radioactive material" means radioactive material which satisfies the following conditions:

(1) It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule;

(2) The piece or capsule has at least one dimension not less than 5 millimeters (0.197 inch); and

(3) It satisfies the test requirements of § 173.469. Special form encapsulations designed in accordance with the requirements of § 173.389(g) in effect on June 30, 1983, and constructed prior to July 1, 1985 may continue to be used. Special form encapsulations either designed or constructed after June 30, 1985 must meet the requirements of this paragraph.

(aa) "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.

(bb) "Transport index" means the dimensionless number (rounded up to the first decimal place) 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 as follows:

(1) The number expressing the maximum radiation level in millirem per hour at one meter (3.3 feet) from the external surface of the package; or

(2) For Fissile Class II packages or packages in a Fissile Class III shipment, the number expressing the maximum radiation level at one meter (3.3 feet) from the external surface of the package, or the number obtained by dividing 50 by the allowable number of packages which may be transported together, whichever is larger.

(cc) "Type A package" means a Type A packaging together with its limited radioactive contents. A Type A package does not require competent authority approval, since its contents are limited to A_1 or A_2 .

(dd) "Type B package" means a Type B packaging together with its radioactive contents.

(ee) "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 7 kilograms per square centimeter (100 pounds per square inch) gauge or a relief device which would allow the release of radioactive material to the environment under the hypothetical accident conditions specified in 10 CFR Part 71.

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

(gg) "Type A packaging" means a packaging 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 §§ 173.465 or 173.466, as appropriate.

(hh) "Type B packaging" means a packaging 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.

(ii) "Uncompressed gas" means, for the purpose of this subpart, gas at a pressure not exceeding the ambient atmospheric pressure at the time and location the containment system is closed. All other radioactive gases are considered to be compressed.

(jj) "Unilateral approval" means approval by the competent authority of the country of origin only.

(kk) "Unirradiated thorium" means thorium containing not more than 10^{-7} grams uranium-233 per gram of thorium-232.

(ll) "Unirradiated uranium" means uranium containing not more than 10^{-6} grams plutonium per gram of uranium-235 and a fission product activity of not more than 0.25 millicuries of fission products per gram of uranium-235.

Sec. 173.411 General design requirements.

Except for a package that contains a limited quantity or excepted instrument or article under §§ 173.421 through 173.424, each package used for shipment of radioactive materials shall be designed so that—

(a) The package can be easily handled and properly secured in or on conveyance during transport;

(b) A package with a gross weight exceeding 10 kilograms (22 pounds) and up to 50 kilograms (110 pounds) has a means for manual handling;

(c) A package with a gross weight of 50 kilograms (110 pounds) or more can be safely handled by mechanical means;

(d) Each lifting attachment on the package, when used in the intended manner, with a minimum safety factor of three, does not impose an unsafe stress on the structure of the package. In addition, the lifting attachment shall be so designed that failure under excessive load would not impair the ability of the package to meet all other requirements of this subpart. Each attachment or other feature on the outer surface of the packaging that could be used to lift the package must be removable or otherwise capable of being made inoperable for transport, or shall be designed with strength equivalent to that required for lifting attachments;

(e) The external surface, as far as practicable, may be easily decontaminated;

(f) The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect; and

(g) Each feature that is added to the package at the time of transport and that is not a part of the package, will not reduce the safety of the package.

Sec. 173.412 Additional design requirements for Type A packages.

In addition to meeting the general design requirements prescribed in § 173.411, each Type A packaging shall be designed so that:

(a) The smallest overall external dimension of the package is not less than 10 centimeters (4 inches);

(b) The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in exclusive use closed transport vehicles, the cargo compartment may be sealed instead of the individual packages;

(c) As far as practicable, the external surfaces are free from protrusions and are designed and finished so that they can be easily decontaminated;

(d) Containment and shielding would be maintained during transportation and storage in a temperature range of -40°C (-40°F) to 70°C (158°F) with account being taken of the possibility of brittle fracture;

(e) It is able to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation, without any deterioration of the effectiveness of closing devices or of the integrity of the package as a whole and without loosening or unintentional release of nuts, bolts, or other securing devices even after repeated use;

(f) It includes a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form, as demonstrated in accordance with § 173.469 may be considered as a component of the containment system;

(g) The materials of the packaging and any components or structures are physically and chemically compatible with each other and with the contents, taking into account the behavior of each under irradiation;

(h) For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis;

(i) The containment system will retain its radioactive contents under the reduction of ambient pressure to .25 kilograms per square centimeter (3.5 pounds per square inch);

(j) Each valve through which the radioactive contents could otherwise escape is protected against damage and unauthorized operation and, except for a pressure relief device, has an enclosure to retain any leakage;

(k) Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield;

(l) Failure of any tie down attachment on the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart;

(m) When subjected to the tests specified in § 173.465 or evaluated against these tests by any of the methods authorized by § 173.461(a), the packaging will prevent:

(1) Loss or dispersal of the radioactive contents; and
(2) Any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test;

(n) Each packaging designed for liquids will:
(1) Meet the conditions prescribed in paragraph (m) of this section when subjected to the tests specified in § 173.466 or evaluated against these tests by any of the methods authorized by § 173.461(a);

(2) For any package with a liquid volume not exceeding 50 cubic centimeters (1.7 fluid ounces), have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material shall be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; and

(3) For any package with a liquid volume exceeding 50 cubic centimeters (1.7 fluid ounces), either:

(i) Have sufficient absorbent material as prescribed in paragraph (n)(2) of this section; or

(ii) Have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer components in the event that the primary inner components leak; and

(o) Each package designed for compressed or uncompressed gases other than tritium or argon-37 not exceeding 200 curies will be able to prevent loss of contents when the package is subjected to the tests prescribed in § 173.466 or evaluated against these tests by any of the methods authorized by § 173.461(a).

Sec. 173.413 Requirements for Type B packages.

Each Type B(U) or Type B(M) package must be designed and

constructed to meet the applicable requirements in 10 CFR Part 71.

Sec. 173.415 Authorized Type A packages.

The following packages are authorized for shipment, if they do not contain quantities exceeding A₁ or A₂ as appropriate:

(a) U.S. Department of Transportation (DOT) Specification 7A (§ 178.350 of this subchapter) Type A general packaging. Each shipper of a Specification 7A package must maintain on file for at least one year after the latest shipment, and shall provide to DOT on request, a complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification. Specification 7A packagings designed in accordance with the requirements of § 178.350 in effect on June 30, 1983, and constructed prior to July 1, 1985, may continue to be used. Packagings either designed or constructed after June 30, 1985, must meet the requirements of § 178.350 applicable at the time of their design or construction.

(b) DOT Specification 55 metal-encased shielded packaging constructed before April 1, 1975. Such packaging constructed after March 31, 1975, is not authorized unless it is requalified under DOT Specification 7A. Each packaging designed for liquids must also meet the requirements of § 173.412 (m) and (n). Use of this packaging as DOT Specification 55 is not authorized after June 30, 1985.

(c) Any Type B, B(U) or B(M) packaging, pursuant to § 173.416.

(d) Any foreign made packaging that bears the marking "Type A" and which was used for the import of radioactive materials. Such packagings may be subsequently used for domestic and export shipments of radioactive materials. These packagings shall conform with requirements of the country of origin (as indicated by the packaging marking) applicable to Type A packagings. (The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under OMB control number 2137-0533).

Sec. 173.416 Authorized Type B packages.

Each of the following packages is authorized for shipment of quantities exceeding A₁ or A₂, as appropriate:

(a) DOT Specification 55 metal-encased shielded packaging constructed before April 1, 1975, for domestic shipments only of special form radioactive materials of 300 curies or less. Such packaging constructed after March 31, 1975 may not be designated as DOT Specification 55. Use of this packaging is not authorized after June 30, 1985 unless approved in accordance with paragraph (b) of this section.

(b) Any Type B, Type B(U) or Type B(M) packaging that meets the applicable requirements in the regulations of the U.S. Nuclear Regulatory Commission (10 CFR Part 71) and that has been approved by that Commission may be shipped pursuant to § 173.471.

(c) Any Type B(U) or B(M) packaging that meets the applicable requirements of the regulations of the International Atomic Energy Agency (IAEA) in its "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6" and for which the foreign competent authority certificate has been revalidated by DOT pursuant to § 173.473. This packaging is authorized only for export and import shipments.

(d) DOT Specification 6M (§ 178.354 of this subchapter) metal packaging, only for solid or gaseous radioactive materials that will not undergo pressure generating decomposition at temperatures up to 121°C (250°F) and that do not generate more than 10 watts of radioactive decay heat.

(e) For contents in other than special form; DOT Specification 20 WC (§ 178.362 of this subchapter), wooden protective jacket, when used with a single, snug-fitting inner DOT Specification 2R (§ 178.360 of this subchapter), or a DOT Specification 55 container constructed prior to April 1, 1975. Such packagings constructed after March 31, 1975, may not be designated as DOT Specification 55. For liquid contents, the inner packaging must comply with § 173.412 (m) and (n).

(f) For contents in special form only; DOT Specification 20WC (§ 178.362 of this subchapter), wooden protective jacket, with a single snug-fitting inner Type A packaging that has a metal outer wall and conforms to § 178.350 of this subchapter, or an inner DOT Specification 55 packaging constructed prior to April 1, 1975. Such packagings constructed after March 31, 1975, may not be designated as DOT Specification 55. Radioactive decay heat may not exceed 100 watts.

(g) For contents in special form only; DOT Specification 21WC (§ 178.364 of this subchapter), wooden protective overpack, with a single inner DOT Specification 2R (§ 178.360 of this subchapter) or an inner DOT Specification 55 container constructed prior to April 1, 1975. Such packagings constructed after March 31, 1975, may not be designated as DOT Specification 55. Contents shall

be loaded within the inner packaging in such a manner as to prevent loose movement during transportation. The inner packaging shall be securely positioned and centered within the overpack so that there will be no significant displacement of the inner packaging if subjected to the 9 meter (30 feet) drop test described in 10 CFR Part 71.

Sec. 173.417 Authorized packaging—fissile materials.

(a) Except as provided in § 173.453, fissile materials containing not more than A₁ or A₂ as appropriate, shall be packaged in one of the following packagings:

(1) DOT Specification 6L (§ 178.352 of this subchapter), metal packaging, for materials prescribed in paragraph (b)(1) of this section.

(2) DOT Specification 6M (§ 178.354 of this subchapter), metal packaging, for materials prescribed in paragraph (b)(2) of this section.

(3) Any packaging listed in § 173.415, limited to the following radioactive materials:

(i) 500 grams of uranium-235 in a single shipment as Fissile Class III or not more than 40 grams of uranium-235 per package as Fissile Class II. For Fissile Class II shipments, the transport index assigned to each package shall not be less than 0.4 for each gram of uranium-235 above 15 grams up to the maximum of 40 grams (transport index of 10).

(ii) 320 grams of plutonium-239 as plutonium-beryllium neutron sources in special form. Total radioactivity content may not exceed 20 curies. The transport index to be assigned to each package must be 0.5 for each 20 grams, or fraction thereof, of fissile plutonium.

(4) Any other Type A, Type B, Type B(U), or Type B(M) packaging for fissile radioactive materials that also meets the applicable standards for fissile materials in the regulations of the U.S. Nuclear Regulatory Commission (10 CFR Part 71), and is used in accordance with § 173.471.

(5) Any other Type A or Type B, Type B(U), or Type B(M) packaging that also meets the applicable requirements for fissile material packaging in Section V of the International Atomic Energy Agency "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6," and for which the foreign competent authority certificate has been revalidated by the U.S. Competent Authority, in accordance with § 173.473. These packages are authorized only for export and import shipments.

(6) A 55-gallon 1A2 steel drum, subject to the following conditions:

(i) The quantity may not exceed 350 grams of uranium-235 in any nonpyrophoric form, enriched to any degree in the uranium-235 isotope.

(ii) Each drum must have a minimum 18 gauge body and bottom head and 16 gauge removable top head with one or more corrugations in the cover near the periphery.

(iii) Closure must conform to § 178.352 of this subchapter.

(iv) At least four equally spaced 12 millimeter (0.5 inch) diameter vent holes shall be provided on the sides of the drum near the top, each covered with weatherproof tape; or equivalent device.

(v) Appropriate primary inner containment of the contents and sufficient packaging material, such as plastic or metal jars or cans shall be provided such that Specification 7A (§ 178.350 of this subchapter) provisions are satisfied by the inner packaging.

(vi) Each inner container shall be capable of venting if subjected to the thermal test described in 10 CFR Part 71.

(vii) Liquid contents shall be packaged in accordance with § 173.412(m) and (n).

(viii) The maximum weight of contents including internal packaging may not exceed 91 kilograms (200 pounds) with fissile material content limited as shown in Table 2:

TABLE 2.—FISSILE MATERIAL CONTENT AND TRANSPORT INDEX FOR SPECIFICATION 6J OR 17H PACKAGES

Maximum U-235 per package (grams)	Minimum transport index per package as Fissile Class II	Maximum packages per transport vehicle as Fissile Class III
350	1.8	72
300	1.0	129
250	0.5	256
200	0.3	500
150	0.1	500
100	0.1	500
50	(¹)	(¹)

¹ Fissile Class I

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(7) Any metal cylinder that meets the performance requirements of §§ 173.415 and 178.350 of this subchapter for Specification 7A Type A packaging may be used as a Fissile Class I package for

the transport of residual "heels" of enriched solid uranium hexafluoride without a protective overpack in accordance with Table 3:

TABLE 3.—ALLOWABLE CONTENT OF URANIUM HEXAFLUORIDE (UF₆) "HEELS" IN A SPECIFICATION 7A CYLINDER

Maximum cylinder diameter		Cylinder volume		Maximum Uranium-235 enrichment (weight percent)	Maximum "heel" weight per cylinder			
Inches	Centimeters	Cubic Feet	Liters		UF ₆		Uranium-235	
					kg	(lb)	kg	(lb)
5	12.7	0.311	8.8	100.0	0.045	0.1	0.031	0.07
8	20.3	1.359	39	12.5	0.227	0.5	0.19	0.04
12	30.5	2.410	68	5.0	0.454	1.0	0.15	0.03
30	76	25.64	725	5.0	11.3	25.0	383	0.84
48	122	108.9 (10 ton)	3084	4.5	22.7	50	690	1.52
		142.7 (14 ton)	4041	4.5	22.7	50	690	1.52

(8) Packagings as prescribed in paragraph (b)(5) of this section, for materials, quantities and conditions as authorized and prescribed therein.

(b) Fissile radioactive materials with radioactive content exceeding A₁ or A₂ shall be packaged in one of the following packagings:

(1) DOT Specification 6L (§ 178.352 of this subchapter), metal packaging. Authorized only for uranium-235, plutonium-239 or plutonium-241, as metal, oxide, or compounds that do not decompose at temperatures up to 149°C (300°F). Radioactive decay heat output may not exceed 5 watts. Radioactive materials in normal form shall be packaged in one or more tightly sealed metal cans or polyethylene bottles within a DOT Specification 2R (§ 178.360 of this subchapter) containment vessel. Packages are authorized as Fissile Class II and III with materials limited in accordance with Table 4:

TABLE 4.—AUTHORIZED CONTENTS IN KILOGRAMS (KG) AND CONDITIONS FOR SPECIFICATION 6L PACKAGES

Uranium-235		Plutonium ¹		Fissile Class II Transport Index	Fissile Class III maximum number of packages per transport vehicle
² H/X ≤ 3	3 ≤ H/Z ≤ 20	H/X ≤ 10	10 ≤ H/X ≤ 20		
14	³ 3.6	—	—	1.3	80
—	—	2.5	2.4	1.8	50

¹ Plutonium solutions are not authorized
² H/X is the ratio of hydrogen to fissile atoms in the inner containment with all sources of hydrogen in the containment considered.
³ Volume not to exceed 3.6 liters

(2) DOT Specification 6M (§ 178.354 of this subchapter), metal packaging. Authorized only for solid radioactive materials that will not decompose at temperatures up to 121°C(250°F). Radioactive decay heat output may not exceed 10 watts. Radioactive materials in other than special form shall be packaged in one or more tightly sealed metal cans or polyethylene bottles within a DOT Specification 2R (§ 178.360 of this subchapter) containment vessel. For fissile materials:

(i) Fissile Class I packages are limited to the following amounts of fissile radioactive materials: 1.6 kilograms of uranium-235; 0.9 kilograms of plutonium (except that due to the 10-watt thermal decay heat limitation, the limit for plutonium-238 is 0.02 kilograms); and 0.5 kilograms of uranium-233. The maximum ratio of hydrogen to fissile material must not exceed three, including all of the sources of hydrogen within the DOT Specification 2R containment vessel.

(ii) Maximum quantities of fissile material for Fissile Class II and Fissile Class III, and other restrictions are given in Table 5. For a Fissile Class II package, the minimum transport index to be assigned is shown in Table 5 and for a Fissile Class III shipment, the allowable number of similar packages per conveyance and per transport vehicle is shown. Each Fissile Class III shipment is also subject to the requirements in § 173.457. Where a maximum ratio of hydrogen to fissile material is specified in Table 5, only the hydrogen interspersed with the fissile material need be considered. For a uranium-233 shipment, the maximum inside diameter of the inner containment vessel must not exceed 12.1 centimeters (4.75 inches). Where necessary, a tight fitting steel insert shall be used to reduce a larger diameter inner containment vessel specified in § 178.104-3(b) of this subchapter to the 12 centimeter (4.75 inch) limit.

TABLE 5.—AUTHORIZED CONTENTS FOR SPECIFICATION 6M PACKAGES¹

Uranium-233 ⁵			Uranium-235 ^{4,7}			Plutonium ^{2,3,4}			Fissile class II transport index	Fissile class III maximum number of packages per transport vehicle		
Metal or alloy	Compounds		Metal or alloy	Compounds		Metal or alloy	Compounds					
⁸ H/X=0	H/X=0	H/X ≤ 3	H/X=0	H/X=0	H/X ≤ 3	H/X=0	H/X=0	H/X ≤ 3				
3.6	4.4	2.9	7.2	7.6	5.3	3.1	4.1	3.4	2500	1000	0.1	1,250
4.2	5.2	3.5	8.7	9.6	6.4	3.4	4.5	4.1	1250	500	0.2	625
5.2	6.8	4.5	11.2	13.9	8.3	4.2	.	4.5	500	200	0.5	250
	.....	.....	13.5	16.0	10.1	4.5	.	.	250	100	1.0	125
	.....	.....		26.0	16.1				50	20	5.0	25
	.....	.....		32.0	19.5				2.5	10	10.0	12

¹ Quantity in kilograms
² Minimum percentage of plutonium-240 is 5 weight percent
³ 4.5 kilogram limitation of plutonium due to 10 watt decay heat limitation
⁴ For a mixture of uranium-235 and plutonium an equal amount of uranium-235 may be substituted for any portion of plutonium authorized
⁵ Maximum inside diameter of Specification 2R containment vessel not to exceed 12 centimeter (4.75 inch) (see par (b)(2)(ii) of this section)
⁶ Granulated or powdered metal with any particle less than 8 millimeter (0.25 inch) in the smallest dimension is not authorized
⁷ Maximum permitted uranium-235 enrichment is 93.5 percent
⁸ H/X is the ratio of hydrogen to fissile atoms in the inner containment

(3) Type B, or Type B(U) or B(M) packaging that meets the standards for packaging of fissile materials in 10 CFR Part 71, and is approved by the U.S. Nuclear Regulatory Commission in accordance with § 173.471.

(4) Type B(U) or B(M) packaging that meets the applicable requirements for fissile radioactive materials in Section V of the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6" and for which the foreign competent authority certificate has been revalidated by the U.S. Competent Authority in accordance with § 173.473. These packagings are authorized only for import and export shipments.

(5) DOT Specifications 20PF-1, 20PF-2, or 20PF-3 (§ 178.356

of this subchapter) or Specifications 21PF-1, 21PF-1A, 21PF-1B, or 21PF-2 (§ 178.358 of this subchapter) phenolic-foam insulated overpack with snug fitting inner metal cylinders, meeting all requirements of §§ 173.24, 173.411, and 173.412 and the following:

(i) Handling procedures and packaging criteria must be in accordance with DOE Report ORO-651 or ANSI Standard N-14.1.

(ii) DOT Specification 21PF-1 overpacks in use or under construction before April 1, 1989, must be modified to DOT Specification 21PF-1A before April 1, 1991. Use of unmodified DOT 21PF-1 overpacks is prohibited after March 31, 1991. All new construction to DOT Specification 21PF-1

Handwritten notes:
 5 gal
 30 gal
 26.5"
 21.2" x 10

Handwritten notes:
 For FCI
 Max = 1250
 If not
 NOT 1250
 1250 1250
 250 625
 250 250
 250 125
 50 25
 2.5 12

beginning after March 31, 1989, must meet DOT Specification 21PF-1B
 (iii) Quantities of uranium hexafluoride are authorized as shown

in Table 6, with each package to be shipped as Fissile Class II, and assigned a minimum transport index as also shown

TABLE 6.—AUTHORIZED QUANTITIES OF URANIUM HEXAFLUORIDE (UF₆) AS FISSILE CLASS II

Protective overpack specification number	Maximum inner cylinder diameter		Maximum weight of UF ₆ contents		Maximum U-235 enrichment (weight percent)	Fissile Class II transport index
	Centimeter	Inch	Kilograms	Pounds		
20PF-1 ^{1,4}	12.7	5	25	55	100.0	0.1
20PF-2	20.3	8	116	255	12.5	4.0
20PF-3	30.5	12	209	460	5.0	1.1
21PF-1 ¹	2 ² 76	2 ³⁰	2,247	4,950	5.0	5.0
	3 ⁷⁶	3 ³⁰	2,279	5,020	5.0	5.0
21PF-2 ¹	2 ² 76	2 ³⁰	2,247	4,950	5.0	6.0
	3 ⁷⁶	3 ³⁰	2,279	5,020	5.0	5.0

¹ For 76 centimeter cylinders, the maximum permitted H/U atomic ratio is 0.088
² Model 30A inner cylinder (Reference: ORO-651)
³ Model 30B inner cylinder (Reference: ORO-651)
⁴ 21PF-1 series includes the 21PF-1, 21PF-1A, and 21PF-1B. Allowable quantities are identical for all three overpacks. See the limitations on usage in paragraph (b)(5) of this section

Sec. 173.418 Authorized packaging-pyrophoric radioactive materials.

(a) Pyrophoric radioactive materials, as referenced in § 172.101 of this subchapter, in quantities not exceeding A₂ per package shall be packaged in Type A packagings which are constructed of materials which will not react nor be decomposed by the contents. Contents must be:

- (1) In solid form and must not be fissile unless excepted by § 173.453;
 - (2) Contained in sealed and corrosion resistant receptacles with positive closures (friction or slip-fit covers or stoppers are not authorized);
 - (3) Free of water and any contaminants which would increase the reactivity of the material; and
 - (4) Made inert to prevent self-ignition during transport by either:
 - (i) Mixing with large volumes of inerting materials such as graphite or dry sand, or other suitable inerting material, or blended into a matrix of hardened concrete; or
 - (ii) By filling the innermost receptacle with an appropriate inert gas.
- (b) In addition to the applicable requirements of § 173.24 each package must be capable of passing the test conditions of § 173.465 without leakage of contents

Sec. 173.419 Authorized packaging-oxidizing radioactive materials.

Certain oxidizing radioactive materials, as referenced in § 172.101 of this subchapter, and which are not fissile materials and not in quantities exceeding A₂, shall be packed in suitable inside packagings of glass, metal or compatible plastic and suitably cushioned with a material which will not react with the contents. Inner packaging and cushioning shall be enclosed within an outside packaging of wood, metal, or plastic. The package shall be capable of meeting the applicable test requirements of § 173.465 without leakage of contents. For shipment by air, the maximum quantity in any package may not exceed 11.3 kilograms (25 pounds).

Sec. 173.420 Uranium hexafluoride (fissile and low specific activity). (a) In addition to any other applicable requirements of this subchapter, uranium hexafluoride, fissile or low specific activity, must be offered for transportation as follows:

- (1) Before initial filling and during periodic inspection and test, packagings must be cleaned in accordance with American National Standard N14.1.
- (2) Packagings must be designed, fabricated, inspected, tested and marked in accordance with—
 - (i) American National Standard N14.1 (1987, 1982 or 1971 edition) in effect at the time the packaging was manufactured;
 - (ii) Specifications for Class DOT-106A multi-unit tank car tanks (§§ 179.300 and 179.301 of this subchapter); or
 - (iii) Section VIII, Division I of the ASME Code, provided the packaging—
 - (A) Was manufactured on or before June 30, 1987;
 - (B) Conforms to the edition of the ASME Code in effect at the time the packaging was manufactured;
 - (C) Is used within its original design limitations; and
 - (D) Has shell and head thicknesses that have not decreased below the minimum value specified in the following table—

Packaging model	Minimum thickness millimeters (inches)
1S, 2S	1.58 (0.062)
5A, 5B, 8A	3.17 (0.125)
12A, 12B	4.76 (0.187)
30B	7.93 (0.312)
48A, F, X, and Y	12.70 (0.500)
48T, O, OM, OM Allied, HX, M, and G	6.35 (0.250)

- (3) Uranium hexafluoride must be in solid form.
- (4) The volume of solid uranium hexafluoride, except solid depleted uranium hexafluoride, at 20°C (68°F.) must not exceed 61% of the certified volumetric capacity of the packaging. The volume of solid depleted uranium hexafluoride at 20°C (68°F.) must not exceed 62% of the certified volumetric capacity of the packaging.
- (5) The pressure in the package at 20°C (68°F) must be less than 101.3 kPa (14.8 psia).
- (b) Packagings of uranium hexafluoride must be periodically inspected, tested, marked and otherwise conform with the American National Standard N14.1-1987.
- (c) Each repair to a packaging for uranium hexafluoride must be performed in accordance with American National Standard N14.1-1987.

Sec. 173.421 Limited quantities of radioactive materials.

Radioactive materials whose activity per package does not exceed the limits specified in § 173.423 are excepted from the specification packaging, shipping paper and certification, marking, and labeling requirements of this subchapter and requirements of this subpart if:

- (a) The materials are packaged in strong, tight packages that will not leak any of the radioactive materials during conditions normally incident to transportation;
- (b) The radiation level at any point on the external surface of the package does not exceed 0.5 millirem per hour;
- (c) The nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in § 173.443(a);
- (d) The outside of the inner packaging or if there is no inner packaging, the outside of the packaging itself bears the marking "Radioactive";
- (e) Except as provided in § 173.424, the package does not contain more than 15 grams of uranium-235; and
- (f) The material is otherwise prepared for shipment as specified in § 173.421-1.

Sec. 173.421-1 Additional requirements for excepted packages containing Class 7 (radioactive) materials.

(a) Excepted packages prepared for shipment under the provisions of § 173.421, 173.422, 173.424, or 173.427 of this subpart 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 the statement "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package—

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limited quantity of material, UN2910; 49 CFR 173.422 for radioactive material, excepted package—instruments or articles, UN2910; 49 CFR 173.424 for radioactive material, excepted package—articles manufactured from natural or depleted uranium or natural thorium, UN2910; or 49 CFR 173.427 for radioactive material, excepted package—empty packaging, UN2910," as appropriate.

(b) An excepted radioactive material classed radioactive material and prepared for shipment under the provisions of § 173.421, § 173.422, § 173.424, § 173.427, or § 173.421-2 is not subject to the requirements of this subchapter, except for:

(1) Sections 171.15, 171.16, 174.750, 176.710 and 177.861 of this subchapter pertaining to the reporting of incidents and decontamination when transported by a mode other than air; or

(2) Sections 171.15, 171.16, 175.45, and 175 700(b) of this subchapter pertaining to the reporting of incidents and decontamination if transported by aircraft.

(Approved by the Office of Management and Budget under control number 2137-0039)

Sec. 173.421-2 Requirements for multiple hazard limited quantity radioactive materials.

(a) Except as provided in paragraph (b) of this section or in § 173.4 of this subchapter, when a limited quantity Class 7 material meets the definition of another hazard class or division, it shall be:

(1) Classed for the additional hazard;

(2) Packaged to conform with the requirements specified in § 173.421(a) through (e) or § 173.422(a) through (g), as appropriate; and

(3) Offered for transportation in accordance with the requirements applicable to the hazard for which it is classed.

(b) When a limited quantity Class 7 material meets the definition of Class 9 or is a combustible liquid in a non-bulk packaging, it shall be:

(1) Classed as a Class 7 material if:

(i) The material is not a hazardous substance, a hazardous waste, or a marine pollutant; and

(ii) The material is offered for transportation in a mode to which requirements of this subchapter pertaining to the specific material do not apply;

(2) Classed combustible liquid or Class 9, as appropriate, if:

(i) The material is a hazardous substance, a hazardous waste, or a marine pollutant; or

(ii) The material is offered for transportation in a mode to which requirements of this subchapter pertaining to the specific material do apply;

(3) Packaged to conform with requirements specified in § 173.421(a) through (e) or § 173.422(a) through (g), as appropriate; and

(4) Offered for transportation in accordance with requirements applicable to the hazard for which it is classed.

(c) A limited quantity Class 7 material which is classed other than Class 7 under the provisions of paragraphs (a) or (b) of this section is excepted from the requirements of §§ 173.421-1(a), 172.203(d), and 172.204(c)(4) of this subchapter if the entry "Limited quantity radioactive material" appears on the shipping paper in association with the basic description.

Sec. 173.422 Exceptions for instruments and articles.

Instruments and manufactured articles (including clocks, electronic tubes or apparatus) or similar devices having radioactive materials in gaseous or non-dispersible solid form as a component part are excepted from the specification packaging, shipping paper and certification, marking and labeling requirements of this subchapter and requirements of this subpart, if:

(a) The activity of the instrument or article does not exceed the relevant limit listed in table 7 § 173.423;

(b) The total activity per package does not exceed the relevant limit listed in Table 7 in § 173.423;

(c) The radiation level at 10 centimeters (4 inches) from any point on the external surface of any unpackaged instrument or articles does not exceed 10 millirem per hour;

(d) The radiation level at any point on the external surface of a packaging bearing the article or instrument does not exceed 0.5 millirem per hour, or, for exclusive use domestic shipments, 2 millirem per hour;

(e) The nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in § 173.443(a);

(f) Except as provided in § 173.424, the package does not contain more than 15 grams of uranium-235; and (g) [Reserved]

(h) The instrument or article is otherwise prepared for shipment as specified in § 173.421-1.

Sec. 173.423 Table of activity limits—excepted quantities and articles.

The limits applicable to instruments, articles and limited quantities subject to exceptions under §§ 173.421 and 173.422 are shown in Table 7:

TABLE 7.—ACTIVITY LIMITS FOR LIMITED QUANTITIES, INSTRUMENTS, AND ARTICLES

Nature of contents	Instruments and Articles		Materials package limits
	Instrument and article limits ¹	Package limits	
Solids:			
Special form	10 ⁻² A ₁	A ₁	10 ⁻³ A ₁
Other forms	10 ⁻² A ₂	A ₂	10 ⁻³ A ₂
Liquids:			
Tritiated water:			
<0.1 Ci/liter . . . .	. . . . .	. . . . .	1000 Curies
0.1 Ci to 1.0 Ci/l . . . .	. . . . .	. . . . .	100 Curies
>1.0 Ci/liter . . . .	. . . . .	. . . . .	1 Curie
Other liquids	10 ⁻³ A ₂	10 ⁻¹ A ₂	10 ⁻⁴ A ₂₊
Gases:			
Tritium 2	20 Curies	200 Curies	20 Curies
Special form	10 ⁻³ A ₁	10 ⁻² A ₁	10 ⁻³ A ₁
Other forms	10 ⁻³ A ₂	10 ⁻² A ₂	10 ⁻³ A ₂

¹ For mixture of radionuclides see § 173.433(b)

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

Sec. 173.424 Excepted articles containing natural uranium or thorium.

Manufactured articles in which the sole radioactive material content is natural or depleted uranium or natural thorium are excepted from the specification packaging, shipping paper and certification, marking and labeling requirements of this subchapter and requirements of this subpart if:

(a) The outer surface of the uranium or thorium is enclosed in an inactive sheath made of metal or other durable protective material;

(b) The conditions specified in § 173.421 (b), (c) and (d) are met; and

(c) The article is otherwise prepared for shipment as specified in § 173.421-1.

Sec. 173.425 Transport requirements for low specific activity (LSA) radioactive materials.

In addition to other applicable requirements specified in this subchapter, low specific activity (LSA) materials shall be transported in accordance with paragraph (a) of this section, or if transported as exclusive-use may be transported in accordance with paragraph (b) or (c) of this section.

(a) DOT Specification 7A (§ 178.350 of this subchapter) Type A package. The requirements of § 173.412 (a), (b), (d), and (n) do not apply.

(b) Packaged shipments of LSA material consigned as exclusive use shall either be in accordance with paragraph (a) of this section or shall comply with the following in which case they are excepted from specification packaging, marking and labeling:

(1) Materials must be packaged in strong, tight packages so that there will be no leakage of radioactive material under conditions normally incident to transportation.

(2) Packages must not have any significant removable surface contamination (see § 173.443).

- (3) External radiation levels must comply with § 173.441.
- (4) Shipments must be loaded by consignor and unloaded by consignee from the conveyance or freight container in which originally loaded.
- (5) There must be no loose radioactive material in the conveyance.
- (6) Shipment must be braced so as to prevent shifting of lading under conditions normally incident to transportation.
- (7) Except for shipments of unconcentrated uranium or thorium ores, the transport vehicles must be placarded with the placards prescribed in accordance with Subpart F of Part 172 of this subchapter, as appropriate.
- (8) The exterior of each package must be stenciled or otherwise marked "Radioactive-LSA". Packages, with a capacity of 110 gallons or less, that contain a hazardous substance, must be stenciled or otherwise marked with the letters "RQ" in association with the above description. For vessel transportation, packages that contain a marine pollutant must be marked in accordance with § 172.322 of this subchapter.
- (9) Specific instructions for maintenance of exclusive use shipment controls must be provided by the shipper to the carrier. Such instructions must be included with the shipping paper information.
- (10) Transportation by aircraft is prohibited.
- (c) Unpackaged (bulk) shipments of LSA materials shall be transported only in exclusive use closed transport vehicles and shall comply with the following:
 - (1) Authorized materials are limited to the following:
 - (i) Uranium or thorium ores and physical or chemical concentrates of those ores.
 - (ii) Uranium metal or natural thorium metal, or alloys of these materials.
 - (iii) Materials of low radioactive concentration, if the average estimated radioactivity concentration does not exceed 0.001 millicurie per gram and the contribution from materials with an A_2 value (see § 173.435) of less than 0.05 curie does not exceed one percent of the total radioactivity.
 - (iv) Objects of nonradioactive material externally contaminated with radioactive material, if the radioactive material is not readily dispersible and the surface contamination, when averaged over one square meter, does not exceed 0.0001 millicurie per square centimeter of radionuclides for which the A_2 value is less than 0.05 or 0.001 millicurie per square centimeter of other radionuclides. Such objects must be suitably wrapped or enclosed.
 - (2) Bulk liquids must be transported in the following:
 - (i) Specification 103CW, 111A60W7 (§§ 179.200, 179.201, 179.202 of this subchapter) tank cars. Bottom openings in tanks prohibited.
 - (ii) Specification MC 310, MC 311, MC 312, or MC 331 (§§ 178.343 or 178.337 of this subchapter) cargo tanks. Authorized only where the radioactivity concentration does not exceed 10 percent of the specified low specific activity levels (see § 173.403(n)). The requirements of § 173.412(n) do not apply to these cargo tanks. Bottom fittings and valves are not authorized. Trailer-on-flat-car service is not authorized.
- (3) External radiation levels must comply with § 173.441(b).
- (4) Shipments must be loaded by the consignor, and unloaded by the consignee from the conveyance or freight container in which originally loaded.
- (5) Except for shipments of unconcentrated uranium or thorium ores, the transport vehicle must be placarded with the placards prescribed in Subpart F of Part 172 of this subchapter, as appropriate.
- (6) There must be no leakage of radioactive materials from the vehicle.
- (7) Specific instructions for maintenance of exclusive use shipment controls must be provided by the shipper to carrier. Such instructions must be included with the shipping paper information.
- (8) Transportation by aircraft is prohibited.
- (d) Except for transportation by aircraft, low specific activity material that conforms with the provisions specified in 10 CFR 20.306 is excepted from all requirements of this subchapter pertaining to radio-active materials when offered for transportation for disposal or recovery. A material which meets the definition of another hazard class is subject to the provisions of this subchapter relating to that hazard class.

Sec. 173.427 Empty radioactive materials packaging.

A packaging which previously contained radioactive materials and has been emptied of contents as far as practical, is excepted from the shipping paper and certification, marking and labeling requirements of this subchapter, and from requirements of this subpart, provided that:

- (a) It complies with the requirements of § 173.421(b), (c) and (e);
- (b) The packaging is in unimpaired condition and is securely closed so that there will be no leakage of radioactive material under conditions normally incident to transportation;
- (c) Internal contamination does not exceed 100 times the limits specified in § 173.443;
- (d) Any labels previously applied in conformance with Subpart E of Part 172 of this subchapter are removed, obliterated or covered and the "Empty" label prescribed in § 172.450 is affixed to the packaging; and
- (e) The packaging is prepared for shipment as specified in § 173.421-1.

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

- (a) A Type A package shall not contain a quantity of radioactivity greater than A_1 (for special form radioactive material) or A_2 (for normal form radioactive material) as listed in § 173.435, or for radioactive materials not listed in § 173.435, as determined in accordance with § 173.433.
- (b) The limits on activity contained in a Type B, Type B(U), or Type B(M) package are those prescribed in § 173.416 or in the applicable approval certificate under §§ 173.471 or 173.473.

Sec. 173.433 Requirements for determination of A_1 and A_2 values for radionuclides.

- (a) Single radionuclides.
 - (1) For single radionuclides of known identity, the values of A_1 and A_2 are those given in the table in § 173.435. The values of A_1 and A_2 are also applicable for radionuclides contained in (α , n) or (γ , n) neutron sources.
 - (2) For any single radionuclide of known identity, which is not listed in § 173.435, the values of A_1 and A_2 shall be determined in accordance with the following:
 - (i) If the radionuclide emits only one type of radiation, A_1 is determined in accordance with paragraphs (a)(2)(i)(A), (B), (C), and (D) of this section. For radionuclides emitting different kinds of radiation, A_1 is the most restrictive value of those determined for each kind of radiation. However, in both cases, A_1 is restricted to a maximum of 1000 curies. If a parent nuclide decays into a shorter lived daughter, of a half-life not greater than 10 days, A_1 is calculated for both the parent and the daughter, and the more limiting of the two values is assigned to the parent nuclide.
 - (A) For gamma emitters, A_1 is determined by the expression:

$$A_1 = 9/\Gamma \text{ curie}$$
 where Γ is the gamma-ray constant, corresponding to the dose in roentgens per hour at 1 meter per curie; the number 9 results from the choice of 1 rem per hour at a distance of 3 meters as the reference dose-equivalent rate.
 - (B) For x-ray emitters, A_1 is determined by the atomic number (Z) of the nuclide:

$$Z < 55 \quad A_1 = 1000 \text{ curies}$$
 for $Z > 55 \quad A_1 = 200 \text{ curies}$
 - (C) For beta emitters, A_1 is determined by the maximum beta energy (E_{max}) according to Table 8:

TABLE 8— A_1 FOR BETA EMITTERS

E_{max} (MeV)	A_1 (curies)
<0.5	1000
0.5-<1.0	300
1.0-<1.5	100
1.5-<2.0	30
≥ 2.0	10

- (D) For alpha emitters, A_1 is determined by the expression:

$$A_1 = 1000 A_3$$

where A_3 is the value listed in Table 9:

TABLE 9— A_3 VALUES

A_3			
Atomic number	Half-life less than 1,000 days	Half-life 1,000 days to 10^6 years	Half-life greater than 10^6 years
1 to 81	3 curies	50 millicuries	3 curies
82 and above	2 millicuries	2 millicuries	3 curies

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- (ii) For assignment of A_2 values, A_2 is the more restrictive of the following values:
 - (A) The corresponding A_1 .
 - (B) The value A_3 obtained from Table 9.
- (3) For any single radionuclide whose identity is unknown, the value of A_1 is 2 curies and the value of A_2 is 0.002 curies. However, if the atomic number of the radionuclide is less than 82, the value of A_1 is 10 curies and the value of A_2 is 0.4 curies.
 - (b) **Mixture of radionuclides, including radioactive decay chains.**
 - (1) For mixed fission products, where a detailed analysis of the mixture is not carried out, the following activity limits apply:
 - (i) $A_1 = 10$ curies.
 - (ii) $A_2 = 0.4$ curies.
 - (2) A single radioactive decay chain is considered to be a single radionuclide when the radionuclides are present in their naturally occurring portions and no daughter nuclide has a half-life either longer than 10 days or longer than that of the parent nuclide. The activity to be taken into account and the A_1 or A_2 value to be applied are those corresponding to the parent nuclide of that chain. When calculating A_1 or A_2 values, radiation emitted by daughters must be taken into account. However, in the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days or greater than that of the parent nuclide, the parent and daughter nuclides are considered to be mixtures of different nuclides.
 - (3) In the case of a mixture of different radionuclides, where the identity and activity of each radionuclide is known, the permissible activity of each radionuclide R_1, R_2, \dots, R_n must be such that $F_1 + F_2 + \dots + F_n$ is not greater than unity, when—

$$F_1 = \frac{\text{Total activity of } R_1}{A_1(R_1)}$$

$$F_2 = \frac{\text{Total activity of } R_2}{A_1(R_2)}$$

$$F_n = \frac{\text{Total activity of } R_n}{A_1 R_n}$$

Where $A_i (R_1, R_2 \dots R_n)$ is the value of A_1 or A_2 as appropriate for the nuclide $R_1, R_2 \dots R_n$.

(4) (When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the formula given in subparagraph (3) of this paragraph must be applied to establish the values of A_1 or A_2 as appropriate. All the radionuclides whose individual activities are not known (but whose total activity is known) must be classed in a single group and the most restrictive value of A_1 or A_2 applicable to any one of them shall be used as the value of A_1 and A_2 in the denominator of the fraction.

(5) When the identity of each radionuclide is known but the individual activity of the radionuclides is not known, the most restrictive value of A_1 or A_2 applicable to any one of the radionuclides present in the applicable value.

(6) When the identity of the radionuclides is not known, the value of A_1 is 2 curies and the value of A_2 is 0.002 curies. However, if alpha emitters are known to be absent, the value of A_2 is 0.4 curies.

Sec. 173.434 Activity-mass relationships for uranium and natural thorium.¹

Radioactive material	Curies per gram	Grams per Curie
Uranium—(Wt% ²³⁵ U present):		
0.45	5.0×10^{-17}	2.0×10^6
0.72 (natural)	7.06×10^{-17}	1.42×10^6
1.0	7.6×10^{-17}	1.3×10^6
15	1.0×10^{-16}	1.0×10^6
5.0	2.7×10^{-16}	3.7×10^5
10.0	4.8×10^{-16}	2.1×10^5
20.0	1.0×10^{-15}	1.0×10^5
35.0	2.0×10^{-15}	5.0×10^4
50.0	2.5×10^{-15}	4.0×10^4
90.0	5.8×10^{-15}	1.7×10^4
93.0	7.0×10^{-15}	1.4×10^4
95.0	9.1×10^{-15}	1.1×10^4
Natural thorium	2.2×10^{-17}	4.6×10^6

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

Sec. 173.435 Table of A_1 and A_2 values for radionuclides.

Symbol of radionuclide	Element and atomic number	A_1 (Ci)	A_2 (Ci)
		(Special Form)	(Normal Form)
227Ac	Actinium (89)	1000	0.003
228Ac		10	4
105Ag	Silver (47)	40	40
110mAg		7	7
111Ag		100	20
241Am	Americium (95) ¹	8	0.008
243Am		8	0.008
37Ar (compressed or uncompressed)	Argon (18)	1000	1000
41Ar (uncompressed)		20	20
41Ar (compressed)		1	1
73As	Arsenic (33)	1000	400
74As		20	20
76As		10	10
77As		300	20
211At	Astatine (85)	200	7
193Au	Gold (79)	200	200
196Au		30	30
196Au		40	20
199Au		200	25
131Ba	Barium (56)	40	40
133Ba		40	10
140Ba		20	20
7Be	Beryllium (4)	300	300
206Bi	Bismuth (83)	5	5
207Bi		10	10
210Bi (RaE)		100	4
212Bi		6	6
249Bk	Berkelium (97)	1000	1
77Br	Bromine (35)	70	25
82Br		6	6
11C	Carbon (6)	20	20
14C		1000	60
45Ca	Calcium (20)	1000	25
47Ca		20	20
109Cd	Cadmium (48)	1000	70
115mCd		30	30
115Cd		80	20
139Ce	Cerium (58)	100	100
141Ce		300	25
143Ce		60	20
144Ce		10	7
249Cf	Californium (98)	2	0.002
250Cf		7	0.007
252Cf		2	0.009

Symbol of radionuclide	Element and atomic number	A ₁ (Cl)	A ₂ (Cl)
		(Special Form)	(Normal Form)
36Cl	Chlorine (17)	300	10
38Cl		10	10
242Cm	Curium (96)	200	0.2
243Cm		9	0.009
244Cm		10	0.01
245Cm		6	0.006
246Cm		6	0.006
56Co	Cobalt (27)	5	5
57Co		90	90
58mCo		1000	1000
58Co		20	20
60Co		7	7
51Cr	Chromium (24)	600	600
129Cs	Cesium (55)	40	40
131Cs		1000	1000
134mCs		1000	10
134Cs		10	10
135Cs		1000	25
136Cs		7	7
137Cs		30	10
64Cu	Copper (29)	80	25
67Cu		200	25
165Dy	Dysprosium (66)	100	20
166Dy		1000	200
169Er	Erbium (68)	1000	25
171Er		50	20
152mEu	Europium (63)	30	30
152Eu		20	10
154Eu		10	5
155Eu		400	60
18F	Fluorine (9)	20	20
52Fe	Iron (26)	5	5
55Fe		1000	1000
59Fe		10	10
67Ga	Gallium (31)	100	100
68Ga		20	20
72Ga		7	7
153Gd	Gadolinium (64)	200	100
159Gd		300	20
68Ge	Germanium (32)	20	10
71Ge		1000	1000
3H	Hydrogen (1) See T-Tritium		
181Hf	Hafnium (72)	30	25
197mHg	Mercury (80)	200	200
197Hg		200	200
203Hg		80	25
166Ho	Holmium (67)	30	30
123I	Iodine (53)	50	50
125I		1000	70
126I		40	10
129I		1000	2
131I		40	10
132I		7	7
133I		30	10
134I		8	8
135I		10	10
111In	Indium (49)	30	25
113mIn		60	60
114In		30	20
115mIn		100	20
190Ir	Iridium (77)	10	10
192Ir		20	10
194Ir		10	10
42K	Potassium (19)	10	10
43K		20	10
85mKr (uncompressed)	Krypton (36)	100	100
85mKr (compressed)		3	3
85Kr (uncompressed)		1000	1000
85Kr (compressed)		5	5
87Kr (uncompressed)		20	20
87Kr (compressed)		0.6	0.6
140La	Lanthanum (57)	30	30
LSA	Low specific activity material—see § 173.403		
177Lu	Lutetium (71)	300	25
MFP	Mixed fission products	10	0.4
28Mg	Magnesium (12)	6	6
52Mn	Manganese (25)	5	5
54Mn		20	20
56Mn		5	5
99Mo	Molybdenum (42)	100	20
13N	Nitrogen (7)	20	10
22Na	Sodium (11)	8	8
24Na		5	5
93mNb	Niobium (41)	1000	200
95Nb		20	20
97Nb		20	20
147Nd	Neodymium (60)	100	20
149Nd		30	20
59Ni	Nickel (28)	1000	900
63Ni		1000	100
65Ni		10	10
237Np	Neptunium (93)	5	0.005
239Np		200	25
185Os	Osmium (76)	20	20

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Symbol of radionuclide	Element and atomic number	A ₁ (Ci)	A ₂ (Ci)
		(Special Form)	(Normal Form)
191Os		600	200
191mOs		200	200
193Os		100	20
32P	Phosphorus (15)	30	30
230Pa	Protactinium (91)	20	0.8
231Pa		2	0.002
233Pa		100	100
201Pb	Lead (82)	20	20
210Pb		100	0.2
212Pb		6	5
103Pd	Palladium (46)	1000	700
109Pd		100	20
147Pm	Promethium (61)	1000	25
149Pm		100	20
210Po	Polonium (84)	200	0.2
142Pr	Praseodymium (59)	10	10
143Pr		300	20
191Pt	Platinum (78)	100	100
193mPt		200	200
197mPt		300	20
197Pt		300	20
238Pu	Plutonium (94) ¹	3	0.003
239Pu		2	0.002
240Pu		2	0.002
241Pu		1000	0.1
242Pu		3	0.003
223Ra	Radium (88)	50	0.2
224Ra		6	0.5
226Ra		10	0.05
228Ra		10	0.05
81Rb	Rubidium (37)	30	25
86Rb		30	30
87Rb		Unlimited	Unlimited
Rb (natural)		Unlimited	Unlimited
186Re	Rhenium (75)	100	20
187Re		Unlimited	Unlimited
188Re		10	10
Re (natural)		Unlimited	Unlimited
103mRh	Rhodium (45)	1000	1000
105Rh		200	25
222Rn	Radon (86)	10	2
97Ru	Ruthenium (44)	80	80
103Ru		30	25
105Ru		20	20
106Ru		10	7
35S	Sulphur (16)	1000	60
122Sb	Antimony (51)	30	30
124Sb		5	5
125Sb		40	25
46Sc	Scandium (21)	8	8
47Sc		200	20
48Sc		5	5
75Se	Selenium (34)	40	40
31Si	Silicon (14)	100	20
147Sm	Samarium (62)	Unlimited	Unlimited
151Sm		1000	90
153Sm		300	20
113Sn	Tin (50)	60	60
119mSn		100	100
125Sn		10	10
85mSr	Strontium (38)	80	80
85Sr		30	30
87mSr		50	50
89Sr		100	10
90Sr		10	0.4
91Sr		10	10
92Sr		10	10
T (uncompressed)	Tritium (1)	1000	1000
T (compressed)		1000	1000
T (activated luminous paint)		1000	1000
T (adsorbed on solid carrier)		1000	1000
T (tritiated water)		1000	1000
T (other forms)		20	20
182Ta	Tantalum (73)	20	20
160Tb	Terbium (65)	20	10
96mTc	Technetium (43)	1000	1000
96Tc		6	6
97mTc		1000	200
97Tc		1000	400
99mTc		100	100
99Tc		1000	25
125mTe	Tellurium (52)	1000	100
127mTe		300	20
127Te		300	20
129mTe		30	10
129Te		100	20
131mTe		10	10
132Te		7	7
227Th	Thorium (90)	200	0.2
228Th		6	0.008
230Th		3	0.003
231Th		1000	25
232Th		Unlimited	Unlimited
234Th		10	10

Symbol of radionuclide	Element and atomic number	A ₁ (Ci)	A ₂ (Ci)
		(Special Form) Unlimited	(Normal Form) Unlimited
Th (natural)			
Th (irradiated) ²			
200Tl	Thalium (81)	20	20
201Tl		200	200
202Tl		40	40
204Tl		300	10
170Tm	Thulium (69)	300	10
171Tm		1000	100
230U	Uranium (92)	100	0.1
232U		30	0.03
233U		100	0.1
234U		100	0.1
235U		100	0.2
236U		200	0.2
238U		Unlimited	Unlimited
U (natural)		Unlimited	Unlimited
U (enriched) <20%		Unlimited	Unlimited
20% or greater		100	0.1
U (depleted)		Unlimited	Unlimited
U (irradiated) ³		Unlimited	Unlimited
48V	Vanadium (23)	6	6
181W	Tungsten (74)	200	100
185W		1000	25
187W		40	20
127Xe (uncompressed)	Xenon (54)	70	70
127Xe (compressed)		5	5
131mXe (compressed)		10	10
131mXe (uncompressed)		100	100
133Xe (uncompressed)		1000	1000
133Xe (compressed)		5	5
135Xe (uncompressed)		70	70
135Xe (compressed)		2	2
87Y	Yttrium (39)	20	20
90Y		10	10
91mY		30	30
91Y		30	30
92Y		10	10
93Y		10	10
169Yb	Ytterbium (70)	80	80
175Yb		400	25
65Zn	Zinc (30)	30	30
69mZn		40	20
69Zn		300	20
93Zr	Zirconium (40)	1000	200
95Zr		20	20
97Zr		20	20

¹ For shipments solely within the United States the A₁ value is 20 curies for americium and plutonium contained in Am-Be or Pu-Be neutron sources or in nuclear-powered pacemakers
² The values of A₁ and A₂ must be calculated in accordance with the procedure specified in § 173.433 of this subchapter, taking into account the activity of the fission products and of the uranium-233 in addition to that of the thorium
³ The values of A₁ and A₂ must be calculated in accordance with the procedure specified in § 173.433 of this subchapter, taking into account the activity of the fission products and plutonium isotopes in addition to that of the uranium

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Sec. 173.441 Radiation level limitations. (a) Except as provided in paragraph (b) of this section, each package of radioactive materials offered for transportation shall be designed and prepared for shipment so that under conditions normally incident to transportation the radiation level does not exceed 200 millirem per hour at any point on the external surface of the package, and the transport index does not exceed 10.

(b) A package which exceeds the radiation level limits specified in paragraph (a) of this section shall be transported by exclusive use shipment only and if the radiation levels for such shipment must not exceed the following during transportation:

(1) 200 millirem per hour (2 millisievert per hour) on the external surface of the package unless the following conditions are met, in which case the limit is 1000 millirem per hour (10 millisievert per hour).

- (i) The shipment is made in a closed transport vehicle;
- (ii) The package is secured within the vehicle so that its position remains fixed during transportation; and
- (iii) There are no loading or unloading operations between the beginning and end of the transportation;

(2) 200 millirem per hour (2 millisievert per hour) at any point on the outer surface of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load (or enclosure is used), and on the lower external surface of the vehicle;

(3) 10 millirem per hour (0.1 millisievert per hour) at any point 2 meters (6.6 feet) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2 meters (6.6 feet) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle); and

(4) 2 millirem per hour in any normally occupied position in the car or transport vehicle, except that this provision does not apply

to private motor carriers when the personnel are operating under a radiation protection program and wear radiation exposure monitoring devices.

(c) For shipments made under the provisions of paragraph (b) of this section, the shipper shall provide specific written instructions for maintenance of the exclusive use shipment controls to the carrier. The instructions shall be included with the shipping paper information.

(d) Packages exceeding the radiation level or transport index prescribed in paragraph (a) of this section shall not be transported by aircraft.

(e) The written instructions required for exclusive use shipments must be sufficient so that, when followed, they will cause the carrier to avoid actions which will unnecessarily delay delivery or unnecessarily result in increased radiation levels or radiation exposures.

(The information collection requirements contained in paragraph (c) were approved by the Office of Management and Budget under control number 2137-0536)

Sec. 173.442 Thermal limitations. Each package of radioactive material shall be designed, constructed, and loaded so that—

(a) The heat generated within the package because of the radioactive contents will not, at any time during transportation, affect the integrity of the package under conditions normally incident to transportation; and

(b) The temperature of the accessible external surfaces of the loaded package will not, assuming still air in the shade at an ambient temperature of 38°C (100°F), exceed either—

- (1) 50°C (122°F) in other than an exclusive use shipment; or
- (2) 82°C (180°F) in an exclusive use shipment.

Sec. 173.443 Contamination control. (a) The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment shall be kept as low as practicable. The level of non-fixed radioactive contamination

may be determined by wiping an area of 300 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements shall be taken in the most appropriate locations to yield a representative assessment of the non-fixed contamination levels. Except as provided in paragraph (b) of this section, the amount of radioactivity measured on any single wiping material when averaged over the surface wiped shall not exceed the limits given in Table 10 at any time during transport. Other methods of assessment of equal or greater efficiency may be used. When other methods are used the detection efficiency of the method used shall be taken into account and in no case shall the non-fixed contamination on the external surfaces of the package exceed ten times the limits listed in Table 10.

TABLE 10 —REMOVABLE EXTERNAL RADIOACTIVE CONTAMINATION—WIPE LIMITS

Contaminant	Maximum permissible limits	
	uCi/Cm ²	dpm/cm ²
Beta-gamma emitting radionuclides; all radionuclides with half-lives less than ten days; natural uranium; natural thorium; uranium-235; uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical concentrates	10 ⁻⁵	22
All other alpha emitting radionuclides	10 ⁻⁶	2.2

(b) Except as provided in paragraph (d) of this section, in the case of packages transported as exclusive use shipments by rail or public highway only, the removable (non-fixed) radioactive contamination at any time during transport shall not exceed ten times the levels prescribed in paragraph (a) of this section. The levels at the beginning of transport shall not exceed the levels prescribed in paragraph (a) of this section.

(c) Except as provided in paragraph (d) of this section, each transport vehicle used for transporting radioactive materials as an exclusive use shipment which utilizes the provisions of paragraph (b) of this section shall be surveyed with appropriate radiation detection instruments after each use. A vehicle shall not be returned to service until the radiation dose rate at each accessible surface is 0.5 millirem per hour or less, and there is no significant removable (non-fixed) radioactive surface contamination as specified in paragraph (a) of this section.

(d) Paragraph (b) and (c) of this section do not apply to any closed transport vehicle used solely for the transportation by public highway of radioactive material packages with contamination levels that do not exceed 10 times the levels prescribed in paragraph (a) of this section if:

(1) A survey of the interior surfaces of the empty vehicle shows that the radiation dose rate at any point does not exceed 10 millirem per hour at the surface or 2 millirem per hour at 1 meter (3.3 feet) from the surface;

(2) Each vehicle is stenciled with the words "For Radioactive Materials Use Only" in letters at least 76 millimeters (3 inches) high in a conspicuous place on both sides of the exterior of the vehicle; and

(3) Each vehicle is kept closed except for loading or unloading.

Sec. 173.444 Labeling requirements. Each package of radioactive materials, unless excepted by §§ 173.421, 173.422, 173.424, 173.425(b), or 173.427 shall be labeled as provided in Subpart E of Part 172 of this subchapter.

Sec. 173.446 Placarding requirements. See Subpart F of Part 172 of this subchapter.

Sec. 173.447 Storage incident to transportation-general requirements. The following requirements apply to temporary storage during the course of transportation but not to Nuclear Regulatory Commission or Agreement State licensed facilities or U.S. Government owned or contracted facilities.

(a) The number of packages bearing Radioactive Yellow II or Radioactive Yellow III labels stored in any one storage area, such as a transit area, terminal building, store-room, or assembly yard, shall be limited so that the sum of the transport indexes in any individual group of packages does not exceed 50. Groups of these packages must be stored so as to maintain a spacing of at least 6 meters (20 feet) from other groups of packages containing radioactive materials.

(b) Mixing of different kinds of packages, including Fissile Class I packages with Fissile Class II packages, is authorized in accordance with § 173.459 of this subchapter.

Sec. 173.448 General transportation requirements. (a) Each

shipment of radioactive materials shall be secured in order to prevent shifting during normal transportation conditions.

(b) Except as may be specifically required by the competent authority in the applicable certificate, a package of 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 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 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, including Fissile Class I packages with Fissile Class II packages, is authorized in accordance with § 173.459.

(e) No person shall offer for transportation aboard a passenger-carrying aircraft any single package with a transport index greater than 3.0 or an overpack with a transport index greater than 3.0.—

(f) No person shall offer for transportation aboard a passenger carrying aircraft any radioactive material unless that material is intended for use in, or incident to, research, or medical diagnosis or treatment.

(g) If an overpack is used to consolidate individual packages of radioactive materials, the packages shall comply with the packaging, marking, and labeling requirements of this subchapter, and the following:

(1) The overpack shall be labeled as prescribed in § 172.403 of this subchapter except as follows:

(i) the "contents" entry on the label may state "mixed" unless each inside package contains the same radionuclide(s).

(ii) The "activity" entry on the label must be determined by adding together the number of curies of the radioactive materials packages contained therein.

(iii) For a non-rigid overpack, the required label together with required package markings shall be affixed to the overpack by means of a securely attached, durable tag. The transport index shall be determined by adding together the transport indexes of the radioactive materials packages contained therein.

(iv) For a rigid overpack, the transport index shall be determined by:

(A) Adding together the transport indexes of the radioactive materials packages contained in the overpack; or

(B) Except for fissile radioactive materials, direct measurements as prescribed in § 173.403(bb) which have been taken by the person initially offering the packages contained within the overpack for shipment.

(2) The overpack shall be marked as prescribed in Subpart D of Part 172 of this subchapter and § 173.25(a).

(3) The transport index of the overpack shall not exceed 3.0 for passenger-carrying aircraft shipments, or 10.0 for cargo aircraft only shipments.

Sec. 173.451 Fissile materials—general requirements. (a) Except as provided in § 173.453, each package containing fissile radioactive materials must comply with §§173.451 through 173.459.

Sec. 173.453 Fissile materials—exceptions. The requirements of §§ 173.451 through 173.459 do not apply to:

(a) A package containing not more than 15 grams of fissile radionuclides. If the material is transported in bulk, the quantity limitation applies to the conveyance;

(b) A package containing irradiated natural or depleted uranium including the products of irradiation if the irradiation has taken place only in the thermal reactor;

(c) A package containing homogeneous solutions or mixtures where:

(1) The minimum ratio of the number of hydrogen atoms to the number of atoms of fissile radionuclides (H/X) is 5200;

(2) The maximum concentration of fissile radionuclides is 5 grams per liter; and

(3) The maximum mass of fissile radionuclides in the package is 500 grams, except that for a mixture where the total mass of plutonium and uranium-233 does not exceed 1% of the mass of uranium-235 the limit is 800 grams. If the material is transported in bulk, the quantity limitations apply to the conveyance;

(d) A package containing uranium enriched in uranium-235 to a maximum of 1% by weight, and with a total plutonium and uranium-233 content of up to 1% of the mass of uranium-235, if the fissile radionuclides are distributed homogeneously throughout the

package contents, and do not form a lattice arrangement within the package;

(e) A package containing any fissile material if it does not contain more than 5 grams of fissile radionuclides in any 10-liter volume, and if the material is packaged so as to maintain this limit of fissile radionuclide concentration during normal transport;

(f) A package containing not more than one kilogram of plutonium of which not more than 20% by mass may consist of plutonium-239, plutonium-241, or any combination of those radionuclides;

(g) A package containing liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by weight, with total plutonium and uranium-233 not more than 0.1% of the mass of uranium-235; or

(h) A package containing thorium or uranium with not more than 0.72% by weight of fissile material used for shipment solely within the United States.

Sec. 173.455 Classification of fissile materials packages. (a) Except as provided in § 173.453, each package of fissile materials shall be classified as follows:

(1) **Fissile Class I.** Packages that may be transported in unlimited number, and in any arrangement, and that require no nuclear criticality safety controls during transportation. A transport index is not assigned to Fissile Class I packages for the purposes of nuclear criticality safety control, although, the external radiation levels may require a transport index number.

(2) **Fissile Class II.** Packages that may be transported together in any arrangement but in numbers that do not exceed an aggregate transport index of 50. For the purposes of nuclear criticality safety control, individual packages may have a transport index of not less than 0.1 and not more than 10. However, the external radiation levels may require a higher transport index number. These shipments require no nuclear criticality safety control by the shipper during transportation.

(3) **Fissile Class III.** Shipments of packages of fissile materials that do not meet the requirements of Fissile Class I or Fissile Class II and that are controlled in transportation as prescribed in § 173.457 by appropriate arrangements between the shipper and the carrier.

(b) The numerical values for package assignments as Fissile Class I, the transport indexes for Fissile Class II packages, and the conveyance and vehicle limitations for Fissile Class III shipments shall be determined in accordance with 10 CFR Part 71.

Sec. 173.457 Transportation of Fissile Class III shipments—specific requirements. (a) Fissile Class III shipments shall incorporate transportation controls which are performed by the shipper or carrier, as appropriate, and which:

(1) Provide nuclear criticality safety;

(2) Protect against loading, storing, or transporting that shipment with any other fissile material; and

(3) Include in the shipping papers the description required by § 172.203(d) of this subchapter.

(b) Fissile Class III shipments shall be transported:

(1) In a conveyance (transport vehicle if transported by public highway or rail) assigned to the exclusive use of the shipper with a specific restriction for the exclusive use to be provided in the appropriate arrangements between shipper and carrier and with instructions to that effect issued with the shipping papers;

(2) Except for shipments by aircraft, with an escort in a vehicle having the capability, equipment, authority, and instructions to provide administrative controls necessary to assure compliance with this section;

(3) In a conveyance (transport vehicle if transported by public highway or rail) containing no other packages of radioactive material that are required to bear one of the labels prescribed in § 172.403 of this subchapter. Specific arrangements must be made between the shipper and the carrier, with instructions to that effect issued with the shipping papers; or

(4) Under any other procedure specifically authorized by the Associate Administrator for Hazardous Materials Safety in accordance with Part 107 of this subchapter. (Approved by the Office of Management and Budget under OMB control number 2137-0535)

(The information collection requirements contained in paragraph (b) were approved by the Office of Management and Budget under control number 2137-0535)

Sec. 173.459 Mixing of fissile material packages. Shipments of fissile materials packages and the commingling of fissile materials packages with other radioactive materials packages shall be in accordance with the provisions of this section.

(a) Mixing of fissile material packages with other types of radioactive materials, including Fissile Class I with Fissile Class II packages is authorized if the total transport index in any conveyance (transport vehicle if transported by public highway or rail) or storage location does not exceed 50.

(b) For Fissile Class II packages shipped under the exclusive

use provisions of § 173.441(b), the transport index number which is calculated for nuclear criticality control purposes shall not exceed 10 for any single package nor a total of 50 for the conveyance (transport vehicle if transported by public highway or rail).

(c) Fissile Class II packages may be shipped with an external radiation level greater than 10 millirem per hour at 1 meter (3.3 feet), and combined with other packages of the same or different designs in a Fissile Class III shipment, under the conditions prescribed in § 173.457, if:

(1) Each package in the shipment has been assigned a transport index for criticality control purposes in accordance with the Fissile Class II criteria;

(2) The transport index which has been assigned in the package approval for nuclear criticality control purposes does not exceed 10 for any single package;

(3) The total transport index for nuclear criticality control purposes does not exceed 100 for all packages in the shipment;

(4) The shipment complies with § 173.441(b); and

(5) The shipment is not transported by vessel.

(d) A Fissile Class III shipment of packages may be combined with other packages of the same or different design when each package has been assigned a transport index for nuclear criticality control purposes in accordance with Fissile Class II criteria, and may be combined with Fissile Class II packages into a Fissile Class III shipment under the conditions prescribed in § 173.457, if:

(1) The transport index which has been assigned in the package approval for nuclear criticality control purposes does not exceed 50 for any single package;

(2) The total transport index for nuclear criticality control purposes for all packages in the shipment does not exceed 100;

(3) The shipment satisfies the provisions of § 173.441(b) if any package has a radiation level exceeding 10 millirem per hour at 1 meter (3.3 feet) from any accessible external surface of the package; and

(4) The shipment is not transported by vessel.

Sec. 173.461 Demonstration of compliance with tests. (a) Compliance with the test requirements in §§ 173.463 through 173.469 shall be shown by any of the methods prescribed in this paragraph, or by a combination of these methods appropriate for the particular feature being evaluated:

(1) By performance of tests with prototypes or samples of the packaging or special form material as normally presented for transportation, in which case the contents of the packaging for the test shall simulate as closely as practicable the expected normal radioactive contents. The use of non-radioactive substitute contents is encouraged provided that the results of the testing take into account the radioactive characteristics of the contents for which it is being tested;

(2) By reference to a previous, satisfactory demonstration of compliance of a sufficiently similar nature;

(3) By performance of tests with models of appropriate scale incorporating those features that are significant with respect to the item under investigation, when engineering experience has shown results of those tests to be suitable for design purposes. When a scale model is used, the need for adjusting certain test parameters, such as the penetrator diameter or the compressive load, must be taken into account; or

(4) By engineering evaluation or comparative data.

(b) With respect to the initial conditions for the tests under §§ 173.463 through 173.469, except for the water immersion tests, compliance shall be based upon the assumption that the package is in equilibrium at an ambient temperature of 38°C (100°F).

Sec. 173.462 Preparation of specimens for testing. (a) Each specimen (i.e., sample, prototype or scale model) shall be examined before testing to identify and record faults or damage, including:

(1) Divergence from the specifications or drawings;

(2) Defects in construction;

(3) Corrosion or other deterioration; and

(4) Distortion of features.

(b) Any deviation found under paragraph (a) of this section from the specified design shall be corrected or suitably taken into account in the subsequent evaluation.

(c) The containment system of the packaging shall be clearly specified.

(d) The external features of the specimen shall be clearly identified so that reference may be made to any part of it.

Sec. 173.463 Packaging and shielding—testing for integrity. After each of the applicable tests specified in § 173.465 and § 173.466, the integrity of the packaging, or of the packaging and its shielding, shall be retained to the extent required by § 173.412(m) for the packaging being tested.

Sec. 173.465 Type A packaging tests. (a) The proposed packaging with proposed contents must be capable of withstanding the tests prescribed in this section. One prototype may be used for all tests if the requirements of paragraph (b) of this section are complied with.

(b) **Water spray test.** The water spray test must precede each test or test sequence prescribed in this section. The water spray test shall 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 shall 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.

—(c) **Free drop test.** The free drop test consists of a fall onto the target in a manner that causes maximum damage to the safety features being tested, and:

(1) For packages weighing 5,000 kilograms (11,000 pounds) or less, the distance of the fall measured from the lowest point of the packaging to the upper surface of the target shall not be less than 1.2 meters (4 feet).

(2) For packages weighing more than 5,000 kilograms (11,000 pounds), the distance of the fall shall not be less than the distance specified in Table 11, for the applicable packaging weight:

TABLE 11.—FREE-FALL DISTANCE FOR PACKAGINGS WEIGHING MORE THAN 5,000 KILOGRAMS

Packaging weight		Free-fall distance	
Kilograms	Pounds	Feet	Meters
>5,000 to 10,000	>11,000 to 22,000	3	0.9
>10,000 to 15,000	>22,000 to 33,000	2	0.6
More than 15,000	More than 33,000	1	0.3

(3) For Fissile Class II packagings, the free drop specified in subparagraph (1) or (2) of this paragraph shall be preceded by a free drop from a height of .3 meter (1 foot) on each corner. For cylindrical packagings, the .3 meter (1 foot) drop shall be onto each of the quarters of each rim.

(4) For fiberboard or wood rectangular packages not exceeding 50 kilograms (110 pounds) in weight, a separate specimen of the proposed packaging shall be subjected to a free drop onto each corner from a height of .3 meter (1 foot).

(5) For fiberboard cylindrical packages weighing not more than 100 kilograms (220 pounds) a separate specimen of the proposed packaging shall be subjected to a free drop onto each of the quarters of each rim from a height of .3 meter (1 foot).

(6) The target shall have a flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

(d) **Compression test.** The compression test shall last for a period of at least 24 hours and consists of a compressive load equivalent to the greater of the following:

(1) Five times the weight of the actual package; or

(2) 1300 kilograms per square meter (265 pounds per square foot) multiplied by the vertically projected area of the package. The compressive load shall be applied uniformly to two opposite sides of the packaging specimen, one of which must be the base on which the package would normally stand.

(e) **Penetration test.** For the penetration test the packaging specimen shall be placed on a rigid, flat, horizontal surface that will not move while the test is being performed. The test shall consist of:

(1) A bar of 3.2 centimeters (1.25 inches) in diameter with a hemispherical end, weighing 6 kilograms (13.2 pounds) being dropped with its longitudinal axis vertical, onto the center of the weakest part of the packaging specimen, so that, if it penetrates far enough, it will hit the containment system. The bar must not be deformed by the test; and

(2) The distance of the fall of the bar measured from its lower end to the upper surface of the packaging specimen shall not be less than 1 meter (3.3 feet).

Sec. 173.466 Additional tests for Type A packagings designed for liquids and gases. (a) In addition to the tests prescribed in § 173.465, Type A packagings designed for liquids and gases shall be capable of withstanding the following tests:

(1) **Free drop test.** The packaging specimen shall fall onto the target in a manner which will cause it to suffer the maximum damage to its containment. The distance of the fall measured from the

lowest part of the packaging specimen to the upper surface of the target shall be not less than 9 meters (30 feet).

(2) **Penetration test.** The specimen must be subjected to the test specified in § 173.465(e) except that the distance of the fall shall be 1.7 meters (5.5 feet).

Sec. 173.467 Tests for demonstrating the ability of Type B and fissile radioactive materials packagings to withstand accident conditions in transportation. Each Type B packaging or packaging for fissile material shall meet the test requirements prescribed in 10 CFR Part 71 for ability to withstand accident conditions in transportation.

Sec. 173.469 Tests for special form radioactive materials. (a) Special form radioactive materials must meet the test requirements of paragraph (b) of this section. Each solid radioactive material or capsule specimen to be tested shall be manufactured or fabricated so that it is representative of the actual solid material or capsule which will be transported with the proposed radioactive content duplicated as closely as practicable. Any differences between the material to be transported and the test material such as the use of non-radioactive contents shall be taken into account. In addition:

(1) A different specimen may be used for each of the tests;

(2) The specimen must not break or shatter when subjected to the impact, percussion, or bending tests;

(3) The specimen must not melt or disperse when subjected to the heat test; and

(4) After each test, leaktightness or indispersibility of the specimen shall be determined by a method no less sensitive than the leaching assessment prescribed in paragraph (c) of this section. For a capsule resistant to corrosion by water, and which has an internal void volume greater than 0.1 milliliters, an alternative to the leaching assessment is a demonstration of leaktightness of 10^{-4} torr-1/s (1.3×10^{-4} atm-cm³/s) based on air at 25°C (77°F) and one atmosphere differential pressure for solid radioactive content, or 10^{-6} torr-1/s (1.3×10^{-6} atm-cm³/s) for liquid or gaseous radioactive content.

(b) **Test methods:** (1) **Impact Test.** The specimen must fall onto the target from a height of not less than 9 meter (30 feet). The target must be as specified in § 173.465(c)(6);

(2) **Percussion Test.**

(i) The specimen shall be placed on a sheet of lead that is supported by a smooth solid surface, and be struck by the flat face of a steel billet so as to produce an impact equivalent to that resulting from a free fall of 1.4 kilograms (3 pounds) through 1 meter (3.3 feet);

(ii) The flat face of the billet shall be 25 millimeters (1 inch) in diameter with the edges rounded off to a radius of 3 millimeters \pm 0.3 millimeters (.12 inch \pm .012 inch);

(iii) The lead shall be of a hardness within 3.5 to 4.5 on the Vickers scale, and not more than 25 millimeters (1 inch) thick, and shall cover an area greater than that covered by the specimen;

(iv) A fresh surface of lead shall be used for each impact; and

(v) The billet must strike the specimen in a manner that causes maximum damage.

(3) **Bending test.**

(i) This test applies only to long, slender sources with a length of 10 centimeters (4 inches) or more and with a length at least 10 times the minimum width;

(ii) The specimen must be securely clamped in a horizontal position so that one half of its length protrudes from the face of the clamp;

(iii) The position of the specimen must be such that it will suffer maximum damage when its free end is struck by the flat face of a steel billet;

(iv) The billet must strike the specimen in a manner that produces an impact equivalent to that resulting from a free vertical fall of 1.4 kilograms (3 pounds) through 1 meter (3.3 feet); and

(v) The flat face of the billet must be 25 millimeters (1 inch) in diameter with the edges rounded off to a radius of 3 millimeters \pm 0.3 millimeters (.12 inch \pm .012 inch)

(4) **Heat test.** The specimen shall be heated in air to a temperature of not less than 800°C (1472°F), held at that temperature for a period of 10 minutes, and the allowed to cool.

(c) **Leaching assessment methods.**

(1) For indispersible solid material—

(i) The specimen shall be immersed for seven days in water at ambient temperature. The water must have a pH of 6–8 and a maximum conductivity of 10 micromho per centimeter at 20°C (68°F);

- (ii) The water and specimen shall then be heated to a temperature of $50^{\circ}\text{C} \pm 5^{\circ}$ ($122^{\circ}\text{F} \pm 9^{\circ}$) and maintained at this temperature for four hours;
 - (iii) The activity of the water shall then be determined;
 - (iv) The specimen shall then be stored for at least seven days in still air with humidity not less than 90 percent at 30°C (86°F);
 - (v) The specimen shall then be immersed in water with the same pH and maximum conductivity specifications as in subparagraph (1)(i) of this paragraph. The water and specimen must be heated to $50^{\circ}\text{C} \pm 5^{\circ}$ ($122^{\circ}\text{F} \pm 9^{\circ}$) and maintained at that temperature for four hours;
 - (vi) The activity of the water shall then be determined. The activities determined in subparagraph (1)(iii) and this subparagraph shall not exceed 0.05 microcuries.
- (2) For encapsulated material—
- (i) The specimen shall be immersed in water at ambient temperature. The water must have a pH of 6–8 and a maximum conductivity of 10 micromho per centimeter. The water and specimen shall be heated to a temperature of $50^{\circ}\text{C} \pm 5^{\circ}$ ($122^{\circ}\text{F} \pm 9^{\circ}$) and maintained at this temperature for four hours;
 - (ii) The activity of the water shall then be determined;
 - (iii) The specimen shall then be stored for at least seven days in still air at a temperature not less than 30°C (86°F);
 - (iv) Step (i) shall be repeated; and
 - (v) The activity of the water shall be determined. The activities determined in paragraph (c)(2)(ii) and this paragraph (c)(2)(v) shall not exceed 0.05 microcuries.

Sec. 173.471 Requirements for U.S. Nuclear Regulatory Commission approved packages. In addition to the applicable requirements of the U.S. Nuclear Regulatory Commission (USNRC) and Parts 171–177 of this subchapter, any shipper of a Type B, Type B(U), Type B(M), or fissile material package that has been approved by the USNRC in accordance with 10 CFR Part 71 shall also comply with the following requirements:

- (a) The shipper shall be registered with the USNRC as a party to the approval, and the shipment must be made in compliance with the terms of the approval;
- (b) The outside of each package shall be durably and legibly marked with the package identification marking indicated in the USNRC approval;
- (c) Each shipping paper related to the shipment of the package shall bear the package identification marking indicated in the USNRC approval;
- (d) Before the first export shipment of the package, the shipper shall obtain a U.S. Competent Authority Certificate for that package design or if one has already been issued, the shipper shall register with the U.S. Competent Authority as a user of the certificate. Upon registration as a user of the certificate the shipper will be furnished with a copy of it. The shipper shall then submit a copy of the U.S. Competent Authority Certificate applying to that package design to the national competent authority of each country into or through which the package will be transported, unless a copy has already been furnished;
- (e) [Reserved]
- (f) Each request for a U.S. Competent Authority Certificate as required by the IAEA regulations shall be submitted in writing to the address set forth in paragraph (e) of this section. The request shall be in duplicate and include copies of the applicable USNRC approval and a reproducible drawing showing the make-up of the package. Each request is considered in the order in which it is received. To allow sufficient consideration by the Associate Administrator for Hazardous Materials Safety, requests should be received at least 45 days before the requested effective date; and
- (g) Import and export shipments may be made in accordance with § 171.12 of this subchapter.

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2137–0512. The information collection requirements contained in paragraph (d) were approved under control number 2137–0515)

Sec. 173.472 Requirements for exporting DOT Specification Type B and fissile packages. (a) Any shipper who exports a DOT Specification Type B or fissile material package authorized by §§ 173.416 or 173.417 shall comply with paragraphs (b) through (f) of this section.

- (b) The shipper shall register with the U.S. Competent Authority as a user of the appropriate U.S. Competent Authority Certificate and the shipment shall be made in accordance with the certificate;
- (c) The outside of each package must be durably and legibly marked with the package identification marking indicated in the U.S. Competent Authority Certificate;
- (d) Each shipping paper related to the shipment of the package

must bear the package identification marking indicated in the U.S. Competent Authority Certificate;

(e) Before the first export shipment of the package, the shipper must submit a copy of the U.S. Competent Authority Certificate applying to that package design to the national competent authority of each country into or through which the package will be transported, unless a copy has already been furnished; and

(f) Import and export shipments may be made in accordance with § 171.12 of this subchapter.

(The information collection requirements contained in paragraphs (b) and (e) were approved by the Office of Management and Budget under control number 2137–0515)

Sec. 173.473 Requirements for foreign-made packages. In addition to other applicable requirements of this subchapter, each shipper of a foreign-made Type B, Type B(U), Type B(M), or fissile material package for which a competent authority certificate is required by the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6," shall also comply with the following requirements:

- (a) Prior to the first shipment of such a package of radioactive materials into or from the U.S., the shipper shall:
 - (1) Have the foreign competent authority certificate revalidated by the U.S. Competent Authority, unless this has been done previously. The request must be in duplicate and contain all the information required by Section VIII of the IAEA regulations. Each request is considered in the order in which it is received. To allow sufficient consideration by the Associate Administrator for Hazardous Materials Safety, requests should be received at least 45 days before the requested effective date.
 - (2) Submit a copy in English of the foreign competent authority certificate with the request for revalidation;
 - (3) Register its identity in writing with the U.S. Competent Authority as a user of the package covered by the foreign competent authority certificate and its revalidation. If the shipper is requesting the revalidation, this automatically done by the Associate Administrator for Hazardous Materials Safety; and
 - (4) Supply to the carrier, upon request, the applicable competent authority certificates. However, the competent authority certificates are not required to accompany the packages to which they apply.
- (b) The outside of each package shall be durably and legibly marked with the same competent authority identification marking indicated on the competent authority certificate and revalidation;
- (c) Each shipping paper for a shipment of radioactive materials shall bear a notation of the package identification marking indicated on the competent authority certificate or revalidation;
- (d) All requirements of the foreign competent authority certificate and the U.S. Competent Authority revalidation shall be fulfilled; and
- (e) Import and export shipments may be made in accordance with § 171.12 of this subchapter.

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2137–0517)

Sec. 173.474 Quality control for construction of packaging. (a) Prior to the first use of any packaging for the shipment of radioactive material, the shipper shall determine, that:

- (1) The packaging meets the quality of design and construction requirements as specified in this subchapter; and
- (2) The effectiveness of the shielding, containment, and, when required, the heat transfer characteristics of the package, are within the limits specified for the package design.

Sec. 173.475 Quality control requirements prior to each shipment of radioactive materials. Before each shipment of any radioactive materials package, the shipper shall ensure by examination or appropriate tests, that:

- (a) The packaging is proper for the contents to be shipped;
- (b) The packaging is in unimpaired physical condition, except for superficial marks;
- (c) Each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects;
- (d) For fissile material, each moderator and neutron absorber, if required, is present and in proper condition;
- (e) Each special instruction for filling, closing, and preparation of the packaging for shipment has been followed;
- (f) Each closure, valve, or other opening of the containment system through which the radioactive content might escape is properly closed and sealed;
- (g) Each packaging containing liquid in excess of an A_2 quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than 0.25 atmosphere, absolute, (0.25 kilograms per square centimeter or 3.6 psia). The test must be conducted on the entire containment system, or on any receptacle or vessel within the containment system, to determine compliance with this requirement;

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- (h) The internal pressure of the containment system will not exceed the design pressure during transportation; and
- (i) External radiation and contamination levels are within the allowable limits specified in this subchapter.

Sec. 173.476 Approval of special form radioactive materials. (a) Each shipper of special form radioactive materials shall maintain on file for at least one year after the latest shipment, and provide to the RSPA on request, a complete safety analysis, including documentation of any tests, demonstrating that the special form material meets the requirements of § 173.469. An IAEA Certificate of Competent Authority issued for the special form material may be used to satisfy this requirement.

(b) Prior to the first export shipment of a special form radioactive material from the United States, each shipper shall obtain a Competent Authority Certificate for the specific material. For special form material manufactured outside the United States an IAEA Certificate of Component Authority from the country of origin may be used to meet this requirement. For special form materials manufactured in the United States each shipper shall obtain a U.S. Competent Authority Certificate for the specific material. Each petition for a U.S. Competent Authority Certificate shall be submitted in accordance with § 173.471(e) and must include the following information:

- (1) A detailed description of the material or if a capsule, a detailed description of the contents. Particular reference must be made to both physical and chemical states;
- (2) If a capsule is to be used, a detailed statement of its design and dimensions, including complete engineering drawings and schedules of material, and methods of construction; and
- (3) A statement of the tests that have been made and their results; evidence based on calculative methods to show that the material is able to pass the tests; or other evidence that the special form radioactive material complies with § 173.469.

(c) Paragraphs (a) and (b) of this section do not apply in those cases where A_1 equals A_2 and the material is not described on the shipping papers as "Radioactive Material, Special Form, n.o.s."

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2137-0516. The information collection requirements contained in paragraph (b) were approved under control number 2137-0518)

Sec. 173.477 Approval for export shipments. (a) Each export shipment of a package for which an IAEA certificate of competent authority has been issued or revalidated in accordance with §§ 173.471, 173.472, or 173.473 shall have multilateral approval, if the shipment includes:

- (1) A vented Type B(M) package;
- (2) A Type B(M) packaging containing radioactive materials with an activity greater than $3 \times 10^3 A_1$, or $3 \times 10^3 A_2$, as appropriate, or 3×10^4 curies, whichever is less;
- (3) A Fissile Class III shipment; or
- (4) Transportation by special arrangement.

- (b) Each application for shipment approval shall contain:
 - (1) The period of time for which the approval is sought;
 - (2) A description of the contents, the expected modes of transportation, the type of conveyance to be used, and the proposed route; and
 - (3) An explanation of how the special precautions and special administrative and operational controls referred to in the package design certificates are to be put into effect.
- (c) The packaging and shipment approvals may be combined into a single approval issued in accordance with §§ 173.471, 173.472 or 173.473.
- (d) Approval by competent authorities is not required for packagings designed for materials covered by §§ 173.421 through 173.427 nor for Type A packagings designed for non-fissile radioactive materials.

(The information collection requirements contained in paragraph (b) were approved by the Office of Management and Budget under control number 2137-0532)

Sec. 173.478 Notification to competent authorities for export shipments. (a) Before the first export shipment of any packaging with contents exceeding A_1 or A_2 , the shipper shall ensure that copies of each applicable competent authority certificate issued in accordance with §§ 173.471, 173.472, or 173.473 have been submitted to the competent authority of each country through which or into which it is to be transported. The shipper is not required to await an acknowledgment from the competent authority prior to shipping the radioactive material, nor is the competent authority required to acknowledge receipt of the certificate.

(b) For each of the shipments described in this paragraph, the shipper shall notify the competent authority of each country through which or into which the shipment is to be transported. This notification must be received by each competent authority at least 15 days before the shipment starts for the following:

- (1) Type B(U) packagings containing radioactive materials with an activity greater than $3 \times 10^3 A_1$, $3 \times 10^3 A_2$, as appropriate, or 3×10^4 curies, whichever is the least;
- (2) Type B(M) packages;
- (3) Fissile Class III shipments under Section VIII of the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)"; or
- (4) Transportation by special arrangements.

(c) The shipper notification must include—

- (1) Sufficient information to enable the packaging to be identified, including all applicable certificate numbers and identification marks; and
- (2) Information as to the date of shipment, the expected date of arrival, and the proposed routing.

(d) The shipper is not required to send a separate notification if the required information has been included in the application for shipment approval.

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2137-0515. The information collection requirements contained in paragraphs (b) and (c) were approved under control number 2137-0532)

Subpart J — [RESERVED]

Subpart K — [RESERVED]

Subpart L — [RESERVED]

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Not more than 50 tear gas devices and
50 functioning elements must be
packed in one box, and the gross
weight of the outer box may not
exceed 35 kg (77 pounds).

(2) In a UN 1A2 metal drum. Func-
tioning elements must be packed in a
separate inner packaging or compart-
ment. Not more than 24 tear gas de-
vices and 24 functioning elements
must be packed in one outer drum,
and the gross weight of the drum may
not exceed 35 kg (77 pounds).

(3) In a UN 4G fiberboard box with
inside tear gas devices meeting Specifi-
cations 2P or 2Q. Each inside packag-
ing must be placed in fiberboard tubes
fitted with metal ends or a fiber box
with suitable padding. Not more than
30 inner packagings must be packed in
one outer box, and the gross weight of
the outer box may not exceed 16 kg
(35 pounds).

(4) In other packagings of a type or
design which has been approved by
the Associate Administrator for Haz-
ardous Materials Safety.

(d) Tear gas devices may be shipped
completely assembled when offered by
or consigned to the U.S. Department
of Defense, provided the functioning
elements are so packed that they
cannot accidentally function. Outer
packagings must be UN 4C1, 4C2, 4D,
or 4F metal-strapped wooden boxes.

[Amdt. 173-224, 55 FR 52669, Dec. 21, 1990]

Subpart H—[Reserved]

Subpart I—Radioactive Materials

AUTHORITY: 49 U.S.C. 1803, 1804, 1808; 49
CFR 1.53, app. A to part 1.

SOURCE: Amdt. 173-162, 48 FR 10226, Mar.
10, 1983, unless otherwise noted.

§ 173.401 Scope.

(a) This subpart sets forth require-
ments for the transportation of radio-
active materials by carriers and ship-
pers subject to this subchapter. The
requirements prescribed in this sub-
part are in addition to, but not in lieu
of, other requirements set forth in this
subchapter and in 10 CFR part 71 for
the packaging and transportation of
radioactive materials.

(b) This subpart does not apply to:

(1) Radioactive materials produced,
used, transported, or stored within an
establishment other than during the
course of transportation.

(2) Radioactive materials contained
in a medical device, such as a heart
pacemaker, which is implanted in a
human being or live animal.

(3) Radiopharmaceuticals that have
been injected into, or ingested by, and
are still in human beings or live ani-
mals.

§ 173.403 Definitions.

In this subpart:

(a) *A₁* means the maximum activity
of special form radioactive material
permitted in a Type A package.

(b) *A₂* means the maximum activity
of radioactive material, other than
special form or low specific activity ra-
dioactive material, permitted in a
Type A package. These values are
either listed in § 173.435 or may be de-
rived in accordance with the procedure
prescribed in § 173.433.

(c) *Closed transport vehicle* means a
transport vehicle equipped with a se-
curely attached exterior enclosure
that during normal transportation re-
stricts the access of unauthorized per-
sons to the cargo space containing the
radioactive materials. The enclosure
may be either temporary or perma-
nent, and in the case of packaged ma-
terials may be of the "see-through"
type, and must limit access from top,
sides, and ends.

(d) *Containment system* means the
components of the packaging intended
to retain the radioactive contents
during transportation.

(e) *Conveyance* means:

(1) For transport by public highway
or rail: any transport vehicle or large
freight container;

(2) For transport by vessel: any
vessel, or any hold, compartment, or
defined deck area of a vessel; and

(3) For transport by aircraft: any air-
craft.

(f) *Depleted uranium* means urani-
um containing less uranium-235 than
the naturally occurring distribution of
uranium isotopes.

(g) *Design* means the description of
a special form material, a package, or
a packaging, 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.

(h) *Enriched uranium* means uranium containing more uranium-235 than the naturally occurring distribution of uranium isotopes.

(i) *Exclusive use* (also referred to in other regulations as *sole use* or *full load*) means the sole use of a conveyance by a single consignor and for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee. Any loading or unloading must be performed by personnel having radiological training and resources appropriate for safe handling of the consignment. Specific instructions for maintenance of exclusive use shipment controls must be issued in writing and included with the shipping paper information provided to the carrier by the consignor.

(j) *Fissile material* means any material consisting of or containing one or more fissile radionuclides. Fissile radionuclides are plutonium-238, plutonium-239, plutonium-241, uranium-233 and uranium-235. Neither natural nor depleted uranium are fissile material. Fissile materials are classified according to the controls needed to provide nuclear criticality safety during transportation, as provided in § 173.455. Certain exclusions are provided in § 173.453.

(k) *Freight container* means a reusable container having a volume of 1.81 cubic meters (64 cubic feet) or more, designed and constructed to permit 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 are designated as *large freight containers*.

(l) *Highway route controlled quantity* means a quantity within a single package which exceeds:

(1) 3000 times the A_2 value of the radionuclides as specified in § 173.433 for special form radioactive material;

(2) 3000 times the A_2 value of the radionuclides as specified in § 173.433 for normal form radioactive material, or

(3) 30,000 curies, whichever is least.

(m) *Limited quantity of radioactive material* means a quantity of radioactive material not exceeding the materials package limits specified in § 173.423 and which conform with requirements specified in § 173.421.

(n) *Low specific activity material (LSA)* means any of the following:

(1) Uranium or thorium ores and physical or chemical concentrates of those ores.

(2) Unirradiated natural or depleted uranium or unirradiated natural thorium.

(3) Tritium oxide in aqueous solutions provided the concentration does not exceed 5.0 millicuries per milliliter.

(4) Material in which the radioactivity is essentially uniformly distributed and in which the estimated average concentration of contents does not exceed:

(i) 0.0001 millicurie per gram of radionuclides for which the A_2 quantity is not more than .05 curie;

(ii) 0.005 millicurie per gram of radionuclides for which the A_2 quantity is more than .05 curie, but not more than 1 curie; or

(iii) 0.3 millicurie per gram of radionuclides for which the A_2 quantity is more than 1 curie.

(5) Objects of nonradioactive material externally contaminated with radioactive material, provided that the radioactive material is not readily dispersible and the surface contamination, when averaged over an area of 1 square meter, does not exceed 0.0001 millicurie (220,000 disintegrations per minute) per square centimeter of radionuclides for which the A_2 quantity is not more than .05 curie, or 0.001 millicurie (2,200,000 disintegrations per minute) per square centimeter for other radionuclides.

(o) *Multilateral approval* means approval by both the appropriate competent authority of the country of origin and of each country through or into which the shipment is to be transported. This definition does not imply approval from countries over which radioactive materials are carried in air-

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craft, if there is no that country.

(p) *Natural thorium* with the naturally tion of thorium is 100 weight percent

(q) *Natural uranium* with the naturally tion of uranium mately 0.711 weigh 235 and the remain nium-238).

(r) *Non-fixed radiation* means radiation that can be rea a surface by wiping material. Non-fixed active contamination if it does not exce fied in § 173.443.

(s) *Normal form al* means radioacti has not been demo as *special form radi*

(t) *Package mea materials, the pack: its radioactive con for transport.*

(u) *Packaging me materials, the assen necessary to ensur the packaging req subpart. It may con receptacles, absorbe ing structures, the diation shielding, a ing or absorbing* The conveyance, ti auxiliary equipme be designated as pa

(v) *Radiation let ation dose-equival millirem per hour flux densities may radiation levels acc*

TABLE 1—NEUTRON F REGARDED AS EQUIV LEVEL OF 1 MILLIREM

	Energy of neutron
Thermal
5 keV
20keV

craft. If there is no scheduled stop in that country.

(p) *Natural thorium* means thorium with the naturally occurring distribution of thorium isotopes (essentially 100 weight percent thorium-232).

(q) *Natural uranium* means uranium with the naturally occurring distribution of uranium isotopes (approximately 0.711 weight percent uranium-235 and the remainder essentially uranium-238).

(r) *Non-fixed radioactive contamination* means 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.

(s) *Normal form radioactive material* means radioactive material which has not been demonstrated to qualify as *special form radioactive material*.

(t) *Package* means, for radioactive materials, the packaging together with its radioactive contents as presented for transport.

(u) *Packaging* means, for 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, 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.

(v) *Radiation level* means the radiation dose-equivalent rate expressed in millirem per hour (mrem/h). Neutron flux densities may be converted into radiation levels according to Table 1:

TABLE 1—NEUTRON FLUX DENSITIES TO BE REGARDED AS EQUIVALENT TO A RADIATION LEVEL OF 1 MILLIREM PER HOUR (MREM/H)¹

Energy of neutron	Flux density equivalent to 1 mrem/h (Neutrons per square centimeter per second)(n/cm ² /s)
Thermal	268.0
5 keV	228.0
20keV	112.0

TABLE 1—NEUTRON FLUX DENSITIES TO BE REGARDED AS EQUIVALENT TO A RADIATION LEVEL OF 1 MILLIREM PER HOUR (MREM/H)¹—Continued

Energy of neutron	Flux density equivalent to 1 mrem/h (Neutrons per square centimeter per second)(n/cm ² /s)
100 keV	32.0
500 keV	12.0
1 MeV	7.2
5 MeV	7.2
10 MeV	6.8

¹ Flux densities equivalent for energies between those listed above may be obtained by linear interpolation

(w) *Radioactive article* means any manufactured instruments and articles such as an instrument, clock, electronic tube or apparatus, or similar instruments and articles having radioactive material as a component part.

(x) *Radioactive contents* means the radioactive material, together with any contaminated liquids or gases, within the package.

(y) *Radioactive material* means any material having a specific activity greater than 0.002 microcuries per gram (uCi/g)(see definition of *specific activity*).

(z) *Special form radioactive material* means radioactive material which satisfies the following conditions:

(1) It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule;

(2) The piece or capsule has at least one dimension not less than 5 millimeters (0.197 inch); and

(3) It satisfies the test requirements of § 173.469. Special form encapsulations designed in accordance with the requirements of § 173.389(g) in effect on June 30, 1983, and constructed prior to July 1, 1985 may continue to be used. Special form encapsulations either designed or constructed after June 30, 1985 must meet the requirements of this paragraph.

(aa) *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.

(bb) *Transport index* means the dimensionless number (rounded up to the first decimal place) 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 as follows:

(1) The number expressing the maximum radiation level in millirem per hour at one meter (3.3 feet) from the external surface of the package; or

(2) For Fissile Class II packages or packages in a Fissile Class III shipment, the number expressing the maximum radiation level at one meter (3.3 feet) from the external surface of the package, or the number obtained by dividing 50 by the allowable number of packages which may be transported together, whichever is larger.

(cc) *Type A package* means a Type A packaging together with its limited radioactive contents. A Type A package does not require competent authority approval, since its contents are limited to A₁ or A₂.

(dd) *Type B package* means a Type B packaging together with its radioactive contents.

(ee) *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 7 kilograms per square centimeter (100 pounds per square inch) gauge or a relief device which would allow the release of radioactive material to the environment under the hypothetical accident conditions specified in 10 CFR part 71.

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

(gg) *Type A packaging* means a packaging 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 § 173.465 or § 173.466, as appropriate.

(hh) *Type B packaging* means a packaging 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.

(ii) *Uncompressed gas* means, for the purposes of this subpart, gas at a pressure not exceeding the ambient atmospheric pressure at the time and location the containment system is closed. All other radioactive gases are considered to be compressed.

(jj) *Unilateral approval* means approval by the competent authority of the country of origin only.

(kk) *Unirradiated thorium* means thorium containing not more than 10⁻⁷ grams uranium-233 per gram of thorium-232.

(ll) *Unirradiated uranium* means uranium containing not more than 10⁻⁶ grams plutonium per gram of uranium-235 and a fission product activity of not more than 0.25 millicuries of fission products per gram of uranium-235.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983; 48 FR 13431, Mar. 31, 1983, as amended at 48 FR 31217, July 7, 1983; Amdt. 173-193, 50 FR 41898, Oct. 16, 1985; Amdt. 173-207, 53 FR 38274, Sept. 29, 1988; Amdt. 173-219, 54 FR 40069, Sept. 29, 1989]

§ 173.411 General design requirements.

Except for a package that contains a limited quantity or excepted instrument or article under §§ 173.421 through 173.424, each package used for shipment of radioactive materials shall be designed so that:

(a) The package can be easily handled and properly secured in or on a conveyance during transport;

(b) A package with a gross weight exceeding 10 kilograms (22 pounds) and up to 50 kilograms (110 pounds) has a means for manual handling;

(c) A package with a gross weight of 50 kilograms (110 pounds) or more can be safely handled by mechanical means;

(d) Each lifting attachment on the package, when used in the intended manner, with a minimum safety factor

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of three, does n stress on the stru In addition, the shall be so design excessive load w ability of the f other requireme Each attachment the outer surfac that could be use must be removab ble of being made port, or shall strength equival for lifting attach

(e) The extern practicable, may nated;

(f) The outer la avoid, as far as p crevices where and

(g) Each featur package at the ti that is not a par not reduce the sa

[Amdt. 173-162, 48 as amended at 48 FR

§ 173.412 Addition: for Type A pack

In addition to design requirem § 173.411, each T: be designed so th:

(a) The smalles mension of the than 10 centimet

(b) The outside incorporates a fea that is not readil while intact, is ev age has not beer of packages ship closed transport compartment ma the individual pac

(c) As far as p nal surfaces are t and are designed they can be easily

(d) Containm would be mainta tation and stora range of -40° (158°F) with acc the possibility of

(e) It is able to of any accelerati

of three, does not impose an unsafe stress on the structure of the package. In addition, the lifting attachment shall be so designed that failure under excessive load would not impair the ability of the package to meet all other requirements of this subpart. Each attachment or other feature on the outer surface of the packaging that could be used to lift the package must be removable or otherwise capable of being made inoperable for transport, or shall be designed with strength equivalent to that required for lifting attachments;

(e) The external surface, as far as practicable, may be easily decontaminated;

(f) The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect; and

(g) Each feature that is added to the package at the time of transport, and that is not a part of the package, will not reduce the safety of the package.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31218, July 7, 1983]

§ 173.412 Additional design requirements for Type A packages.

In addition to meeting the general design requirements prescribed in § 173.411, each Type A packaging shall be designed so that:

(a) The smallest overall external dimension of the package is not less than 10 centimeters (4 inches);

(b) The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in exclusive use closed transport vehicles, the cargo compartment may be sealed instead of the individual packages;

(c) As far as practicable, the external surfaces are free from protrusions and are designed and finished so that they can be easily decontaminated;

(d) Containment and shielding would be maintained during transportation and storage in a temperature range of -40°C (-40°F) to 70°C (158°F) with account being taken of the possibility of brittle fracture;

(e) It is able to withstand the effects of any acceleration, vibration, or vibra-

tion resonance that may arise during normal transportation, without any deterioration of the effectiveness of closing devices or of the integrity of the package as a whole and without loosening or unintentional release of nuts, bolts, or other securing devices even after repeated use;

(f) It includes a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form, as demonstrated in accordance with § 173.469 may be considered as a component of the containment system;

(g) The materials of the packaging and any components or structures are physically and chemically compatible with each other and with the contents, taking into account the behavior of each under irradiation;

(h) For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis;

(i) The containment system will retain its radioactive contents under the reduction of ambient pressure to .25 kilograms per square centimeter (3.5 pounds per square inch);

(j) Each valve through which the radioactive contents could otherwise escape is protected against damage and unauthorized operation and, except for a pressure relief device, has an enclosure to retain any leakage;

(k) Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield;

(l) Failure of any tie down attachment on the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart;

(m) When subjected to the tests specified in § 173.465 or evaluated against these tests by any of the methods authorized by § 173.461(a), the packaging will prevent:

(1) Loss or dispersal of the radioactive contents; and

(2) Any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test;

(n) Each packaging designed for liquids will:

(1) Meet the conditions prescribed in paragraph (m) of this section when subjected to the tests specified in § 173.466 or evaluated against these tests by any of the methods authorized by § 173.461(a);

(2) For any package with a liquid volume not exceeding 50 cubic centimeters (1.7 fluid ounces), have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material shall be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; and

(3) For any package with a liquid volume exceeding 50 cubic centimeters (1.7 fluid ounces), either:

(i) Have sufficient absorbent material as prescribed in paragraph (n)(2) of this section; or

(ii) Have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer components in the event that the primary inner components leak; and

(o) Each package designed for compressed or uncompressed gases other than tritium or argon-37 not exceeding 200 curies will be able to prevent loss of contents when the package is subjected to the tests prescribed in § 173.466 or evaluated against these tests by any of the methods authorized by § 173.461(a).

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31218, July 7, 1983]

§ 173.413 Requirements for Type B packages.

Each Type B(U) or Type B(M) package must be designed and constructed to meet the applicable requirements in 10 CFR part 71.

§ 173.415 Authorized Type A packages.

The following packages are authorized for shipment, if they do not contain quantities exceeding A₁ or A₂ as appropriate:

(a) U.S. Department of Transportation (DOT) Specification 7A (§ 178.350 of this subchapter) Type A general packaging. Each shipper of a Specification 7A package must maintain on file for at least one year after the latest shipment, and shall provide to DOT on request, a complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification. Specification 7A packagings designed in accordance with the requirements of § 178.350 in effect on June 30, 1983, and constructed prior to July 1, 1985, may continue to be used. Packagings either designed or constructed after June 30, 1985, must meet the requirements of § 178.350 applicable at the time of their design or construction.

(b) DOT Specification 55 metal-encased shielded packaging constructed before April 1, 1975. Such packaging constructed after March 31, 1975 is not authorized unless it is requalified under DOT Specification 7A. Each packaging designed for liquids must also meet the requirements of § 173.412 (m) and (n). Use of this packaging as DOT Specification 55 is not authorized after June 30, 1985.

(c) Any Type B, B(U) or B(M) packaging pursuant to § 173.416.

(d) Any foreign made packaging that bears the marking "Type A" and which was used for the import of radioactive materials. Such packagings may be subsequently used for domestic and export shipments of radioactive materials. These packagings shall conform with requirements of the country of origin (as indicated by the packaging marking) applicable to Type A packagings.

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2137-0533)

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31218, July 7, 1983; Amdt. 173-197, 51 FR 34987, Oct. 1, 1986]

§ 173.416 Au

Each of the authorized for exceeding A₁ or

(a) DOT : cased shield before April ments only (materials of packaging co 1975 may n Specification is not autho unless appro paragraph (b

(b) Any T B(M) packag cable require of the U.S. mission (10 (been approv may be ship

(c) Any T ing that me ments of the national A (IAEA) in Safe Transp als, Safety S the foreign tificate has pursuant to is authorize import shipm

(d) DOT S of this subc only for sol materials th sure generat peratures up that do not watts of radi

(e) For co cial form; I (§ 178.362 of protective j; single, snug- cation 2R (§ ter), or a D tainer const 1975. Such after March ignated as I liquid conte must compl (n).

(f) For con DOT Specifi this subcha

§ 173.416 Authorized Type B packages.

Each of the following packages is authorized for shipment of quantities exceeding A₁ or A₂, as appropriate:

(a) DOT Specification 55 metal-encased shielded packaging constructed before April 1, 1975, for domestic shipments only of special form radioactive materials of 300 curies or less. Such packaging constructed after March 31, 1975 may not be designated as DOT Specification 55. Use of this packaging is not authorized after June 30, 1985 unless approved in accordance with paragraph (b) of this section.

(b) Any Type B, Type B(U) or Type B(M) packaging that meets the applicable requirements in the regulations of the U.S. Nuclear Regulatory Commission (10 CFR part 71) and that has been approved by that Commission may be shipped pursuant to § 173.471.

(c) Any Type B(U) or B(M) packaging that meets the applicable requirements of the regulations of the International Atomic Energy Agency (IAEA) in its "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6" and for which the foreign competent authority certificate has been revalidated by DOT pursuant to § 173.473. This packaging is authorized only for export and import shipments.

(d) DOT Specification 6M (§ 178.354 of this subchapter) metal packaging, only for solid or gaseous radioactive materials that will not undergo pressure generating decomposition at temperatures up to 121°C (250° F) and that do not generate more than 10 watts of radioactive decay heat.

(e) For contents in other than special form; DOT Specification 20 WC (§ 178.362 of this subchapter), wooden protective jacket, when used with a single, snug-fitting inner DOT Specification 2R (§ 178.360 of this subchapter), or a DOT Specification 55 container constructed prior to April 1, 1975. Such packagings constructed after March 31, 1975, may not be designated as DOT Specification 55. For liquid contents, the inner packaging must comply with § 173.412 (m) and (n).

(f) For contents in special form only; DOT Specification 20WC (§ 178.362 of this subchapter), wooden protective

jacket, with a single snug-fitting inner Type A packaging that has a metal outer wall and conforms to § 178.350 of this subchapter, or an inner DOT Specification 55 packaging constructed prior to April 1, 1975. Such packagings constructed after March 31, 1975, may not be designated as DOT Specification 55. Radioactive decay heat may not exceed 100 watts.

(g) For contents in special form only; DOT Specification 21WC (§ 178.364 of this subchapter), wooden protective overpack, with a single inner DOT Specification 2R (§ 178.360 of this subchapter) or an inner DOT Specification 55 container constructed prior to April 1, 1975. Such packagings constructed after March 31, 1975, may not be designated as DOT Specification 55. Contents shall be loaded within the inner packaging in such a manner as to prevent loose movement during transportation. The inner packaging shall be securely positioned and centered within the overpack so that there will be no significant displacement of the inner packaging if subjected to the 9 meter (30 feet) drop test described in 10 CFR part 71.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31218, July 7, 1983; Amdt. 173-224, 55 FR 52670 Dec. 21, 1990]

§ 173.417 Authorized packaging—fissile materials.

(a) Except as provided in § 173.453, fissile materials containing not more than A₁ or A₂ as appropriate, shall be packaged in one of the following packagings:

(1) DOT Specification 6L (§ 178.352 of this subchapter), metal packaging, for materials prescribed in paragraph (b)(1) of this section.

(2) DOT Specification 6M (§ 178.354 of this subchapter), metal packaging, for materials prescribed in paragraph (b)(2) of this section.

(3) Any packaging listed in § 173.415, limited to the following radioactive materials:

(i) 500 grams of uranium-235 in a single shipment as Fissile Class III or not more than 40 grams of uranium-235 per package as Fissile Class II. For Fissile Class II shipments, the transport index assigned to each package

shall not be less than 0.4 for each gram of uranium-235 above 15 grams up to the maximum of 40 grams (transport index of 10).

(ii) 320 grams of plutonium-239 as plutonium-beryllium neutron sources in special form. Total radioactivity content may not exceed 20 curies. The transport index to be assigned to each package must be 0.5 for each 20 grams, or fraction thereof, of fissile plutonium.

(4) Any other Type A or Type B, Type B(U), or Type B(M) packaging for fissile radioactive materials that also meets the applicable standards for fissile materials in the regulations of the U.S. Nuclear Regulatory Commission (10 CFR part 71), and is used in accordance with § 173.471.

(5) Any other Type A or Type B, Type B(U), or Type B(M) packaging that also meets the applicable requirements for fissile material packaging in Section V of the International Atomic Energy Agency "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6," and for which the foreign competent authority certificate has been revalidated by the U.S. Competent Authority, in accordance with § 173.473. These packages are authorized only for export and import shipments.

(6) A 55-gallon 1A2 steel drum, subject to the following conditions:

(i) The quantity may not exceed 350 grams of uranium-235 in any non-pyrophoric form, enriched to any degree in the uranium-235 isotope.

(ii) Each drum must have a minimum 18 gauge body and bottom head and 16 gauge removable top head with one or more corrugations in the cover near the periphery.

(iii) Closure must conform to § 178.352 of this subchapter.

(iv) At least four equally spaced 12 millimeter (0.5 inch) diameter vent

holes shall be provided on the sides of the drum near the top, each covered with weatherproof tape; or equivalent device.

(v) Appropriate primary inner containment of the contents and sufficient packaging material, such as plastic or metal jars or cans shall be provided such that Specification 7A (§ 178.350 of this subchapter) provisions are satisfied by the inner packaging.

(vi) Each inner container shall be capable of venting if subjected to the thermal test described in 10 CFR part 71.

(vii) Liquid contents shall be packaged in accordance with § 173.412(m) and (n).

(viii) The maximum weight of contents including internal packaging may not exceed 91 kilograms (200 pounds) with fissile material content limited as shown in Table 2:

TABLE 2—FISSILE MATERIAL CONTENT AND TRANSPORT INDEX FOR SPECIFICATION 6J OR 17H PACKAGES

Maximum U-235 per package (grams)	Minimum transport index per package as Fissile Class II	Maximum packages per transport vehicle as Fissile Class III
350	18	72
300	10	129
250	05	256
200	03	500
150	01	500
100	01	500
50	(¹)	(¹)

¹ Fissile Class I

(7) Any metal cylinder that meets the performance requirements of §§ 173.415 and 178.350 of this subchapter for Specification 7A Type A packaging may be used as a Fissile Class I package for the transport of residual "heels" of enriched solid uranium hexafluoride without a protective overpack in accordance with Table 3:

TABLE 3—AL

Maximum cylinder diameter	
Inches	Centimeters
5	1
8	2
12	3
30	
48	

(8) Packaging quantities and (b) Fissile shall be packaged (1) DOT Specification 6J or compound radioactive decay normal form ethylene bottle containment materials limited

TABLE 4—AUTI

Uranium
H/X < 3 ²
14

¹ Plutonium solutions
² H/X is the ratio of considered
³ Volume not to exceed

(2) DOT Specification 7A authorized only for quantities up to 15 watts. Radioactive or more tightly cation 2R (§ 173.415) als:

(i) Fissile Class I active material (except that plutonium-238 is 0 ratio of hydrogen sources of hydrogen

(ii) Maximum weight of Fissile Class III, and other materials the minimum transport index for Fissile Class III shall be in accordance and per tr

TABLE 3—ALLOWABLE CONTENT OF URANIUM HEXAFLUORIDE (UF₆) "HEELS" IN A SPECIFICATION 7A CYLINDER

Maximum cylinder diameter		Cylinder volume		Maximum Uranium-235 enrichment (weight percent)	Maximum "heel" weight per cylinder			
Inches	Centimeters	Cubic Feet	Liters		UF ₆		Uranium-235	
					kg	(lb)	kg	(lb)
5	127	0.311	8.8	100.0	0.045	0.1	0.031	0.07
8	203	1.359	39	12.5	0.227	0.5	0.19	0.04
12	305	2.410	68	5.0	0.454	1.0	0.15	0.03
30	76	25.64	725	5.0	11.3	25.0	363	0.84
48	122	108.9 (10 ton)	3064	4.5	22.7	50	690	1.52
		142.7 (14 ton)	4041	4.5	22.7	50	690	1.52

(8) Packagings as prescribed in paragraph (b)(5) of this section, for materials, quantities and conditions as authorized and prescribed therein.

(b) Fissile radioactive materials with radioactive content exceeding A₁ or A₂ shall be packaged in one of the following packagings:

(1) DOT Specification 6L (§ 178.352 of this subchapter), metal packaging. Authorized only for uranium-235, plutonium-239 or plutonium-241, as metal, oxide, or compounds that do not decompose at temperatures up to 149°C (300°F). Radioactive decay heat output may not exceed 5 watts. Radioactive materials in normal form shall be packaged in one or more tightly sealed metal cans or polyethylene bottles within a DOT Specification 2R (§ 178.360 of this subchapter) containment vessel. Packages are authorized as Fissile Class II and III with materials limited in accordance with Table 4:

TABLE 4—AUTHORIZED CONTENTS IN KILOGRAMS (KG) AND CONDITIONS FOR SPECIFICATION 6L PACKAGES

Uranium-235		Plutonium ¹		Fissile class II transport index	Fissile class III maximum number of packages per transport vehicle
H/X < 3 ²	3 < H/Z < 20	H/X < 10	10 < H/X < 20		
14	³ 3.6	2.5	2.4	1.3 1.8	80 50

¹ Plutonium solutions are not authorized

² H/X is the ratio of hydrogen to fissile atoms in the inner containment with all sources of hydrogen in the containment considered

³ Volume not to exceed 3.6 liters

(2) DOT Specification 6M (§ 178.354 of this subchapter), metal packaging. Authorized only for solid radioactive materials that will not decompose at temperatures up to 121°C (250°F). Radioactive decay heat output may not exceed 10 watts. Radioactive materials in other than special form shall be packaged in one or more tightly sealed metal cans or polyethylene bottles within a DOT Specification 2R (§ 178.360 of this subchapter) containment vessel. For fissile materials:

(i) Fissile Class I packages are limited to the following amounts of fissile radioactive materials: 1.6 kilograms of uranium-235; 0.9 kilograms of plutonium (except that due to the 10-watt thermal decay heat limitation, the limit for plutonium-238 is 0.02 kilograms); and 0.5 kilograms of uranium-233. The maximum ratio of hydrogen to fissile material must not exceed three, including all of the sources of hydrogen within the DOT Specification 2R containment vessel.

(ii) Maximum quantities of fissile material for Fissile Class II and Fissile Class III, and other restrictions are given in Table 5. For a Fissile Class II package, the minimum transport index to be assigned is shown in Table 5 and for a Fissile Class III shipment, the allowable number of similar packages per conveyance and per transport vehicle is shown. Each Fissile Class III shipment is also

subject to the requirements in § 173.457. Where a maximum ratio of hydrogen to fissile material is specified in Table 5, only the hydrogen interspersed with the fissile material need be considered. For a uranium-233 shipment, the maximum inside diameter of the inner containment vessel must not exceed 12.1 centimeters (4.75 inches). Where necessary, a tight fitting steel insert shall be used to reduce a larger diameter inner containment vessel specified in § 178.104-3(b) of this subchapter to the 12 centimeter (4.75 inch) limit.

TABLE 5—AUTHORIZED CONTENTS FOR SPECIFICATION 6M PACKAGES¹

Uranium-233 ⁵			Uranium-235 ⁴			Plutonium ^{2,3,4}			Fissile class II transport index	Fissile class III maximum number of packages per transport vehicle
Metal or alloy	Compounds		Metal or alloy	Compounds		Metal or alloy	Compounds			
⁸ H/X=0	H/X=0	H/X≤3	H/X=0	H/X=0	H/X≤3	H/X=0	H/X=0	H/X≤3		
36	44	2.9	72	76	53	31	41	34	0.1	1,250
⁶ 42	52	3.5	87	96	64	34	4.5	4.1	0.2	625
⁶ 52	68	4.5	112	13.9	83	4.2	..	4.5	0.5	250
..	..	..	135	16.0	10.1	4.5	..	..	1.0	125
..	..	..	..	26.0	16.1	..	..	..	5.0	25
..	..	..	..	32.0	19.5	..	..	..	10.0	12

¹ Quantity in kilograms
² Minimum percentage of plutonium-240 is 5 weight percent.
³ 4.5 kilogram limitation of plutonium due to 10 watt decay heat limitation.
⁴ For a mixture of uranium-235 and plutonium an equal amount of uranium-235 may be substituted for any portion of plutonium authorized
⁵ Maximum inside diameter of Specification 2R containment vessel not to exceed 12 centimeter (4.75 inch) (see par (b)(2)(ii) of this section).
⁶ Granulated or powdered metal with any particle less than 8 millimeter (0.25 inch) in the smallest dimension is not authorized.
⁷ Maximum permitted uranium-235 enrichment is 93.5 percent
⁸ H/X is the ratio of hydrogen to fissile atoms in the inner containment.

(3) Type B, or Type B(U) or B(M) packaging that meets the standards for packaging of fissile materials in 10 CFR part 71, and is approved by the U.S. Nuclear Regulatory Commission in accordance with § 173.471.

(4) Type B(U) or B(M) packaging that meets the applicable requirements for fissile radioactive materials in Section V of the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6" and for which the foreign competent authority certificate has been revalidated by the U.S. Competent Authority in accordance with § 173.473. These packagings are authorized only for import and export shipments.

(5) DOT Specifications 20PF-1, 20PF-2, or 20PF-3 (§ 178.356 of this subchapter), or Specifications 21PF-1, 21PF-1A, 21PF-1B, or 21PF-2 (§ 178.358 of this subchapter) phenolic-foam insulated overpack with snug fitting inner metal cylinders, meeting all requirements of §§ 173.24, 173.411, and 173.412, and the following:

(i) Handling procedures and packaging criteria must be in accordance with DOE Report ORO-651 or ANSI N14.1.

(ii) DOT Specification 21PF-1 overpacks in use or under construction before April 1, 1989, must be modified to DOT Specification 21PF-1A before April 1, 1991. Use of unmodified DOT 21PF-1 overpacks is prohibited after March 31, 1991. All new construction to DOT Specification 21PF-1 beginning after March 31, 1989, must meet DOT Specification 21PF-1B.

(iii) Quantities of uranium hexafluoride are authorized as shown in Table 6, with each package to be shipped as Fissile Class II, and assigned a minimum transport index as also shown:

TABLE 6—/

Protective ov
20PF-1
20PF-2
20PF-3
21PF-1 ^{1,4}
21PF-2 ¹

¹ For 76 centimet
² Model 30A inner
³ Model 30B inner
⁴ 21PF-1 series in the limitations on us

[Amdt. 173-16 FR 31218, Jul; 5973, Feb. 18, 1989; Sept. 20, 1989;

§ 173.418 Aut
phoric rad

(a) Pyroph as reference chapter, in q per package : A packagings materials wh decomposed l must be:

- (1) In solid sile unless ex
- (2) Contain sion resistant closures (fric stoppers are 1
- (3) Free of nants which tivity of the r
- (4) Made in tion during tr
 - (i) Mixing erting mater dry sand, or material, or l hardened con
 - (ii) By fillin cle with an ap
- (b) In addit quirements o must be cap: conditions of age of conten

TABLE 6—AUTHORIZED QUANTITIES OF URANIUM HEXAFLUORIDE (UF₆) AS FISSILE CLASS II

Protective overpack specification number	Maximum inner cylinder diameter		Maximum weight of UF ₆ contents		Maximum U-235 enrichment (weight percent)	Fissile Class II transport index
	Centimeter	Inch	Kilograms	Pounds		
20PF-1	12 7	5	25	55	100 0	0 1
20PF-2	20 3	8	116	255	12 5	4 0
20PF-3	30 5	12	209	460	5 0	1 1
21PF-1 ¹	² 76	² 30	2,247	4,950	5 0	5 0
	³ 76	³ 30	2,279	5,020	5 0	5 0
21PF-2 ¹	² 76	² 30	2,247	4,950	5 0	5 0
	³ 76	³ 30	2,279	5,020	5 0	5 0

¹ For 76 centimeter cylinders, the maximum permitted H/U atomic ratio is 0 088.

² Model 30A inner cylinder (Reference: ORO-651)

³ Model 30B inner cylinder (Reference: ORO-651)

⁴ 21PF-1 series includes the 21PF-1, 21PF-1A, and 21PF-1B. Allowable quantities are identical for all three overpacks. See the limitations on usage in paragraph (b)(5) of this section.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 13432, Mar. 31, 1983; 48 FR 31218, July 7, 1983; Amdt. 173-185, 50 FR 11055, Mar. 19, 1985; Amdt. 173-196, 51 FR 5973, Feb. 18, 1986, Amdt. 173-206, 53 FR 36551, Sept. 20, 1988; Amdt. 173-216, 54 FR 38796, Sept. 20, 1989; Amdt. 173-224, 55 FR 52670 Dec. 21, 1990]

§ 173.418 Authorized packaging-pyrophoric radioactive materials.

(a) Pyrophoric radioactive materials, as referenced in § 172.101 of this subchapter, in quantities not exceeding A₂ per package shall be packaged in Type A packagings which are constructed of materials which will not react nor be decomposed by the contents. Contents must be:

- (1) In solid form and must not be fissile unless excepted by § 173.453;
- (2) Contained in sealed and corrosion resistant receptacles with positive closures (friction or slip-fit covers or stoppers are not authorized);
- (3) Free of water and any contaminants which would increase the reactivity of the material; and
- (4) Made inert to prevent self-ignition during transport by either:
 - (i) Mixing with large volumes of inerting materials such as graphite or dry sand, or other suitable inerting material, or blended into a matrix of hardened concrete; or
 - (ii) By filling the innermost receptacle with an appropriate inert gas.

(b) In addition to the applicable requirements of § 173.24 each package must be capable of passing the test conditions of § 173.465 without leakage of contents.

§ 173.419 Authorized packaging-oxidizing radioactive materials.

Certain oxidizing radioactive materials, as referenced in § 172.101 of this subchapter, and which are not fissile materials and not in quantities exceeding A₂, shall be packed in suitable inside packagings of glass, metal or compatible plastic and suitably cushioned with a material which will not react with the contents. Inner packaging and cushioning shall be enclosed within an outside packaging of wood, metal, or plastic. The package shall be capable of meeting the applicable test requirements of § 173.465 without leakage of contents. For shipment by air, the maximum quantity in any package may not exceed 11.3 kilograms (25 pounds).

§ 173.420 Uranium hexafluoride (fissile and low specific activity).

(a) In addition to any other applicable requirements of this subchapter, uranium hexafluoride, fissile or low specific activity, must be offered for transportation as follows:

- (1) Before initial filling and during periodic inspection and test, packagings must be cleaned in accordance with American National Standard N14.1.

(2) Packagings must be designed, fabricated, inspected, tested and marked in accordance with—

(i) American National Standard N14.1 (1987, 1982 or 1971 edition) in effect at the time the packaging was manufactured;

(ii) Specifications for Class DOT-106A multi-unit tank car tanks (§§ 179.300 and 179.301 of this subchapter); or

(iii) Section VIII, Division I of the ASME Code, provided the packaging—

(A) Was manufactured on or before June 30, 1987;

(B) Conforms to the edition of the ASME Code in effect at the time the packaging was manufactured;

(C) Is used within its original design limitations; and

(D) Has shell and head thicknesses that have not decreased below the minimum value specified in the following table—

[Amdt. 173-214, 54 FR 35652, Aug. 29, 1989]

§ 173.421 Limited quantities of radioactive materials.

Radioactive materials whose activity per package does not exceed the limits specified in § 173.423 are excepted from the specification packaging, shipping paper and certification, marking, and labeling requirements of this subchapter and requirements of this subpart if:

(a) The materials are packaged in strong, tight packages that will not leak any of the radioactive materials during conditions normally incident to transportation;

(b) The radiation level at any point on the external surface of the package does not exceed 0.5 millirem per hour;

(c) The nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in § 173.443(a);

(d) The outside of the inner packaging or if there is no inner packaging, the outside of the packaging itself bears the marking "Radioactive";

(e) Except as provided in § 173.424, the package does not contain more than 15 grams of uranium-235; and

(f) The material is otherwise prepared for shipment as specified in § 173.421-1.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended by Amdt. 173-167, 48 FR 30137, June 30, 1983]

§ 173.421-1 Additional requirements for excepted packages containing Class 7 (radioactive) materials.

(a) Excepted packages prepared for shipment under the provisions of §§ 173.421, 173.422, 173.424, or 173.427 of this subpart 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 the statement "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910; 49 CFR 173.422 for radioac-

tive material, instruments or a 173.424 for re- cepted pack- aged from na- um or natural CFR 173.427 f- excepted pack UN2910," as ap-

(b) An excep- classed radioac- pared for ship- sions of § 173.4- § 173.427 or § to the require- ter, except for:

(1) Sections 176.710 and 17- pertaining to dents and c- transported by or

(2) Sections and 175.700(b) taining to the and decontamin aircraft.

(Approved by th- and Budget und 0039)

[Amdt. 173-167, 4- as amended by A- May 2, 1985; An- Feb. 18, 1986; An- May 1, 1987; Am- Apr. 13, 1989; Ar- Feb. 28, 1991; An- Dec. 20, 1991]

§ 173.421-2 Requ- hazard limit- materials.

(a) Except as (b) of this secti- subchapter, wh- Class 7 materi- of another haz- shall be:

(1) Classed hazard;

(2) Packaged i- requirements spe- through (e) or (g), as appropri-

(3) Offered fo- cordance with t- cable to the h- classed.

(b) When a li- material meets

Packaging model	Minimum thickness millimeters (inches)
1S, 2S.....	1.58 (0.062)
5A, 5B, 8A.....	3.17 (0.125)
12A, 12B.....	4.76 (0.187)
30B.....	7.93 (0.312)
48A, F, X, and Y.....	12.70 (0.500)
48T, O, OM, OM Allied, HX, H, and G.....	6.35 (0.250)

(3) Uranium hexafluoride must be in solid form.

(4) The volume of solid uranium hexafluoride, except solid depleted uranium hexafluoride, at 20 °C (68 °F.) must not exceed 61% of the certified volumetric capacity of the packaging. The volume of solid depleted uranium hexafluoride at 20 °C (68 °F.) must not exceed 62% of the certified volumetric capacity of the packaging.

(5) The pressure in the package at 20 °C (68 °F.) must be less than 101.3 kPa (14.8 psia).

(b) Packagings of uranium hexafluoride must be periodically inspected, tested, marked and otherwise conform with the American National Standard N14.1-1987.

(c) Each repair to a packaging for uranium hexafluoride must be performed in accordance with American National Standard N14.1-1987.

tive material, excepted package—instruments or articles, UN2910; 49 CFR 173.424 for radioactive material, excepted package—articles manufactured from natural or depleted uranium or natural thorium, UN2910; or 49 CFR 173.427 for radioactive material, excepted package—empty packaging, UN2910,” as appropriate.

(b) An excepted radioactive material classed radioactive material and prepared for shipment under the provisions of § 173.421, § 173.422, § 173.424, § 173.427 or § 173.421-2 is not subject to the requirements of this subchapter, except for:

(1) Sections 171.15, 171.16, 174.750, 176.710 and 177.861 of this subchapter pertaining to the reporting of incidents and decontamination when transported by a mode other than air; or

(2) Sections 171.15, 171.16, 175.45, and 175.700(b) of this subchapter pertaining to the reporting of incidents and decontamination if transported by aircraft.

(Approved by the Office of Management and Budget under control number 2137-0039)

[Amdt. 173-167, 48 FR 30137, June 30, 1983, as amended by Amdt. 173-187, 50 FR 18667, May 2, 1985; Amdt. 173-196, 51 FR 5973, Feb. 18, 1986; Amdt. 173-202, 52 FR 15949, May 1, 1987; Amdt. 173-209, 54 FR 14814, Apr. 13, 1989; Amdt. 173-226, 56 FR 8624, Feb. 28, 1991; Amdt. 173-224, 56 FR 66279, Dec. 20, 1991]

§ 173.421-2 Requirements for multiple hazard limited quantity radioactive materials.

(a) Except as provided in paragraph (b) of this section or in § 173.4 of this subchapter, when a limited quantity Class 7 material meets the definition of another hazard class or division, it shall be:

(1) Classed for the additional hazard;

(2) Packaged to conform with the requirements specified in § 173.421 (a) through (e) or § 173.422 (a) through (g), as appropriate; and

(3) Offered for transportation in accordance with the requirements applicable to the hazard for which it is classed.

(b) When a limited quantity Class 7 material meets the definition of Class

9 or is a combustible liquid in a non-bulk packaging, it shall be:

(1) Classed as a Class 7 material if:

(i) The material is not a hazardous waste or hazardous substance; and

(ii) The material is offered for transportation in a mode to which requirements of this subchapter pertaining to the specific material do not apply;

(2) Classed combustible liquid or Class 9, as appropriate, if:

(i) The material is a hazardous waste or hazardous substance; or

(ii) The material is offered for transportation in a mode to which requirements of this subchapter pertaining to the specific material do apply;

(3) Packaged to conform with requirements specified in § 173.421 (a) through (e) or § 173.422 (a) through (g), as appropriate; and

(4) Offered for transportation in accordance with requirements applicable to the hazard for which it is classed.

(c) A limited quantity Class 7 material which is classed other than Class 7 under the provisions of paragraph (a) or (b) of this section is excepted from the requirements of §§ 173.421-1(a), 172.203(d), and 172.204(c)(4) of this subchapter if the entry “Limited quantity radioactive material” appears on the shipping paper in association with the basic description.

[Amdt. 173-224, 55 FR 52670, Dec. 21, 1990, as amended by Amdt. 173-226, 56 FR 8624, Feb. 28, 1991; Amdt. 173-224, 56 FR 66279, Dec. 20, 1991]

§ 173.422 Exceptions for instruments and articles.

Instruments and manufactured articles (including clocks, electronic tubes or apparatus) or similar devices having radioactive materials in gaseous or non-dispersible solid form as a component part are excepted from the specification packaging, shipping paper and certification, marking and labeling requirements of this subchapter and requirements of this subpart, if:

(a) The activity of the instrument or article does not exceed the relevant limit listed in Table 7 in § 173.423;

(b) The total activity per package does not exceed the relevant limit listed in Table 7 in § 173.423;

(c) The radiation level at 10 centimeters (4 inches) from any point on the external surface of any unpackaged instrument or article does not exceed 10 millirem per hour;

(d) The radiation level at any point on the external surface of a package bearing the article or instrument does not exceed 0.5 millirem per hour, or, for exclusive use domestic shipments, 2 millirem per hour;

(e) The nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in § 173.443(a);

(f) Except as provided in § 173.424, the package does not contain more than 15 grams of uranium-235; and

(g) [Reserved]

(h) The instrument or article is otherwise prepared for shipment as specified in § 173.421-1.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended by Amdt. 173-167, 48 FR 30138, June 30, 1983; Amdt. 173-162, 48 FR 31218, July 7, 1983; Amdt. 173-16, 48 FR 50460, Nov. 1, 1983]

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

The limits applicable to instruments, articles, and limited quantities subject to exceptions under §§ 173.421 and 173.422 are shown in Table 7:

TABLE 7—ACTIVITY LIMITS FOR LIMITED QUANTITIES, INSTRUMENTS, AND ARTICLES

Nature of contents	Instruments and articles		Materials package limits
	Instrument and article limits ¹	Package limits	
Solids:			
Special form	10 ⁻² A ₁	A ₁	10 ⁻³ A ₁
Other forms	10 ⁻² A ₂	A ₂	10 ⁻³ A ₂
Liquids:			
Tritiated water:			
<0.1 Ci/liter			1000 Curies
0.1 Ci to 1.0 Ci/l			100 Curies.
> 1.0 Ci/liter			1 Curie.
Other liquids	10 ⁻³ A ₂	10 ⁻³ A ₂	10 ⁻³ A ₂
Gases:			
Tritium ²	20 Curies	200 Curies	20 Curies
Special form	10 ⁻³ A ₁	10 ⁻² A ₁	10 ⁻³ A ₁
Other forms	10 ⁻³ A ₂	10 ⁻² A ₂	10 ⁻³ A ₂

¹ For mixture of radionuclides see § 173.433(b).

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

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 13432, Mar. 31, 1983; 48 FR 31218, July 7, 1983]

§ 173.424 Excepted articles containing natural uranium or thorium.

Manufactured articles in which the sole radioactive material content is natural or depleted uranium or natural thorium are excepted from the specification packaging, shipping paper and certification, marking and labeling requirements of this subchapter and requirements of this subpart if:

(a) The outer surface of the uranium or thorium is enclosed in an inactive sheath made of metal or other durable protective material;

(b) The conditions specified in § 173.421 (b), (c), and (d) are met; and

(c) The article is otherwise prepared for shipment as specified in § 173.421-1.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended by Amdt. 173-167, 48 FR 30138, June 30, 1983; Amdt. 173-162, 48 FR 31218, July 7, 1983]

§ 173.425 Transport requirements for low specific activity (LSA) radioactive materials.

In addition to other applicable requirements specified in this subchapter, low specific activity (LSA) materials shall be transported in accordance with paragraph (a) of this section, or if transported as exclusive-use may be

transported in paragraph (b) or (c)
 (a) DOT Specifications of this subchapter. The requirements (d), and (n) do not apply.
 (b) Packaged material consigned either be in a paragraph (a) of this section, or comply with the case they are excepted from packaging.
 (1) Materials must be strong, tight packaged. There will be no leakage of material under conditions of transport.
 (2) Packages must not require significant removal of material (see § 173.443).
 (3) External surfaces must comply with § 173.443.
 (4) Shipments must be by a consignor and under conditions contained in which (c) of this section.
 (5) There must be no radioactive material in the package.
 (6) Shipments must be prevented from shifting or falling out of the container normally in transport.
 (7) Except for concentrated uranium, the transport vehicle must be placarded with the placard in accordance with subchapter 173.439 of this subchapter.
 (8) The exterior of the container must be stenciled with "Radioactive—LSA" in a capacity of 110 percent. Containers must contain a hazard label and be stenciled or marked with the letters "RQ" in accordance with the above description.
 (9) Specific instructions in the absence of exclusive-use materials must be provided to the carrier. Such instructions must be included with the shipping information.
 (10) Transport of LSA materials is prohibited.
 (c) Unpackaged LSA materials shall be transported only in exclusive-use

transported in accordance with paragraph (b) or (c) of this section.

(a) DOT Specification 7A (§ 178.350 of this subchapter) Type A package. The requirements of § 173.412 (a), (b), (d), and (n) do not apply.

(b) Packaged shipments of LSA material consigned as exclusive use shall either be in accordance with paragraph (a) of this section or shall comply with the following in which case they are excepted from specification packaging, marking and labeling:

(1) Materials must be packaged in strong, tight packages so that there will be no leakage of radioactive material under conditions normally incident to transportation.

(2) Packages must not have any significant removable surface contamination (see § 173.443).

(3) External radiation levels must comply with § 173.441.

(4) Shipments must be loaded by consignor and unloaded by consignee from the conveyance or freight contained in which originally loaded.

(5) There must be no loose radioactive material in the conveyance.

(6) Shipment must be braced so as to prevent shifting of lading under conditions normally incident to transportation.

(7) Except for shipments of unconcentrated uranium or thorium ores, the transport vehicle must be placarded with the placards prescribed in accordance with subpart F of part 172 of this subchapter, as appropriate.

(8) The exterior of each package must be stenciled or otherwise marked "Radioactive—LSA". Packages, with a capacity of 110 gallons or less, that contain a hazardous substance, must be stenciled or otherwise marked with the letters "RQ" in association with the above description.

(9) Specific instructions for maintenance of exclusive use shipment controls must be provided by the shipper to the carrier. Such instructions must be included with the shipping paper information.

(10) Transportation by aircraft is prohibited.

(c) Unpackaged (bulk) shipments of LSA materials shall be transported only in exclusive use closed transport

vehicles and shall comply with the following:

(1) Authorized materials are limited to the following:

(i) Uranium or thorium ores and physical or chemical concentrates of those ores.

(ii) Uranium metal or natural thorium metal, or alloys of these materials.

(iii) Materials of low radioactive concentration, if the average estimated radioactivity concentration does not exceed 0.001 millicurie per gram and the contribution from materials with an A_2 value (see § 173.435) of less than 0.05 curie does not exceed one percent of the total radioactivity.

(iv) Objects of nonradioactive material externally contaminated with radioactive material, if the radioactive material is not readily dispersible and the surface contamination, when averaged over one square meter, does not exceed 0.0001 millicurie per square centimeter of radionuclides for which the A_2 value is less than 0.05 or 0.001 millicurie per square centimeter of other radionuclides. Such objects must be suitably wrapped or enclosed.

(2) Bulk liquids must be transported in the following: (i) Specification 103CW, 111A60W7 (§§ 179.200, 179.201, 179.202 of this subchapter) tank cars. Bottom openings in tanks prohibited.

(ii) Specification MC 310, MC 311, MC 312, or MC 331 (§ 178.343 or § 178.337 of this subchapter) cargo tanks. Authorized only where the radioactivity concentration does not exceed 10 percent of the specified low specific activity levels (see § 173.403(n)). The requirements of § 173.412(n) do not apply to these cargo tanks. Bottom fittings and valves are not authorized. Trailer-on-flat-car service is not authorized.

(3) External radiation levels must comply with § 173.441(b).

(4) Shipments must be loaded by the consignor, and unloaded by the consignee from the conveyance or freight container in which originally loaded.

(5) Except for shipments of unconcentrated uranium or thorium ores, the transport vehicle must be placarded with the placards prescribed in subpart F of part 172 of this subchapter, as appropriate.

(6) There must be no leakage of radioactive materials from the vehicle.

(7) Specific instructions for maintenance of exclusive use shipment controls must be provided by the shipper to the carrier. Such instructions must be included with the shipping paper information.

(8) Transportation by aircraft is prohibited.

(d) Except for transportation by aircraft, low specific activity material that conforms with the provisions specified in 10 CFR 20.306 is excepted from all requirements of this subchapter pertaining to radio-active materials when offered for transportation for disposal or recovery. A material which meets the definition of another hazard class is subject to the provisions of this subchapter relating to that hazard class.

(The information collection requirements contained in paragraph (b)(9) were approved by the Office of Management and Budget under control number 2137-0536. The information collection requirements contained in paragraph (c)(7) were approved by the Office of Management and Budget under control number 2137-0534)

(49 U.S.C. 1803, 1804, 1808; 49 CFR 1.53, app. A to part 1)

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended by Amdt. 173-162, 48 FR 31218, July 7, 1983; Amdt. 173-178, 49 FR 38134, Sept. 27, 1984; Amdt. 173-188, 50 FR 23813, June 6, 1985; Amdt. 172-119, 54 FR 39506, Sept. 26, 1989]

§ 173.427 Empty radioactive materials packaging.

A packaging which previously contained radioactive materials and has been emptied of contents as far as practical, is excepted from the shipping paper and certification, marking and labeling requirements of this subchapter, and from requirements of this subpart, provided that:

(a) It complies with the requirements of § 173.421 (b), (c), and (e);

(b) The packaging is in unimpaired condition and is securely closed so that there will be no leakage of radioactive material under conditions normally incident to transportation;

(c) Internal contamination does not exceed 100 times the limits in § 173.443;

(d) Any labels previously applied in conformance with Subpart E of Part 172 of this subchapter are removed, obliterated or covered and the "Empty" label prescribed in § 172.450 is affixed to the packaging; and

(e) The packaging is prepared for shipment as specified in § 173.421-1.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended by Amdt. 173-196, 51 FR 5973, Feb. 18, 1986; Amdt. 173-204, 52 FR 36672, Sept. 30, 1987]

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

(a) A Type A package shall not contain a quantity of radioactivity greater than A_1 (for special form radioactive material) or A_2 (for normal form radioactive material) as listed in § 173.435, or for radioactive materials not listed in § 173.435, as determined in accordance with § 173.433.

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

[Amdt. 173-162, 48 FR 31218, July 7, 1983]

§ 173.433 Requirements for determination of A_1 and A_2 values for radionuclides.

(a) *Single radionuclides.* (1) For single radionuclides of known identity, the values of A_1 and A_2 are those given in the table in § 173.435. The values of A_1 and A_2 are also applicable for radionuclides contained in (α,n) or (γ,n) neutron sources.

(2) For any single radionuclide of known identity, which is not listed in § 173.435, the values of A_1 and A_2 shall be determined in accordance with the following:

(i) If the radionuclide emits only one type of radiation, A_1 is determined in accordance with paragraphs (a)(2)(i) (A), (B), (C), and (D) of this section. For radionuclides emitting different kinds of radiation, A_1 is the most restrictive value of those determined for each kind of radiation. However, in both cases, A_1 is restricted to a maximum of 1000 curies. If a parent nuclide decays into a shorter lived daughter, of a half-life not greater than 10 days, A_1 is calculated for both the parent and the daughter, and the

more limit signed to th

(A) For g mined by curie

where Γ is t sponding to t at 1 meter p from the cho tance of 3 r equivalent rat

(B) For x mined by t the nuclide:

$Z \leq 55 \quad A_1 =$
 $\text{for } Z > 55$

(C) For b mined by th (E_{max}) accord

TABLE 8

<0.5
0.5-1.0
1.0-1.5
1.5-2.0
≥2.0

(D) For al mined by the

$A_1 = 1000 A_2$
where A_2 is the

TAE

Atomic number	Half-life than 1,000
1 to 81	3 curies
82 and above.	2 millicuries

(ii) For assign the more rest values:

(A) The corr
(B) The va
Table 9.

(3) For ar whose identity of A_1 is 2 curie 0.002 curies. I number of th than 82, the v and the value o

more limiting of the two values is assigned to the parent nuclide.

(A) For gamma emitters, A_1 is determined by the expression: $A_1 = 9/\Gamma$ curie

where Γ is the gamma-ray constant, corresponding to the dose in roentgens per hour at 1 meter per curie; the number 9 results from the choice of 1 rem per hour at a distance of 3 meters as the reference dose-equivalent rate.

(B) For x-ray emitters, A_1 is determined by the atomic number (Z) of the nuclide:

$Z \leq 55$ $A_1 = 1000$ curies
for $Z > 55$ $A_1 = 200$ curies

(C) For beta emitters, A_1 is determined by the maximum beta energy (E_{max}) according to Table 8:

TABLE 8— A_1 FOR BETA EMITTERS

E_{max} (MeV)	A_1 (curies)
<0.5	1000
0.5-1.0	300
1.0-1.5	100
1.5-2.0	30
≥ 2.0	10

(D) For alpha emitters, A_1 is determined by the expression:

$A_1 = 1000 A_3$

where A_3 is the value listed in Table 9:

TABLE 9— A_3 VALUES

Atomic number	A_3		
	Half-life less than 1,000 days	Half-life 1,000 days to 10^6 years	Half-life greater than 10^6 years
1 to 81...	3 curies	50 millicuries.....	3 curies.
82 and above.	2 millicuries.....	2 millicuries ...	3 curies.

(ii) For assignment of A_2 values, A_2 is the more restrictive of the following values:

(A) The corresponding A_1 .

(B) The value A_3 obtained from Table 9.

(3) For any single radionuclide whose identity is unknown, the value of A_1 is 2 curies and the value of A_2 is 0.002 curies. However, if the atomic number of the radionuclide is less than 82, the value of A_1 is 10 curies and the value of A_2 is 0.4 curies.

(b) *Mixture of radionuclides, including radioactive decay chains.* (1) For mixed fission products, where a detailed analysis of the mixture is not carried out, the following activity limits apply:

- (i) $A_1 = 10$ curies.
- (ii) $A_2 = 0.4$ curies.

(2) A single radioactive decay chain is considered to be a single radionuclide when the radionuclides are present in their naturally occurring portions and no daughter nuclide has a half-life either longer than 10 days or longer than that of the parent nuclide. The activity to be taken into account and the A_1 or A_2 value to be applied are those corresponding to the parent nuclide of that chain. When calculating A_1 or A_2 values, radiation emitted by daughters must be taken into account. However, in the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days or greater than that of the parent nuclide, the parent and daughter nuclides are considered to be mixtures of different nuclides.

(3) In the case of a mixture of different radionuclides, where the identity and activity of each radionuclide is known, the permissible activity of each radionuclide $R_1, R_2, \dots R_n$ must be such that $F_1 + F_2 + \dots F_n$ is not greater than unity, when—

$$F_1 = \frac{\text{Total activity of } R_1}{A_1(R_1)}$$

$$F_2 = \frac{\text{Total activity of } R_2}{A_1(R_2)}$$

$$F_n = \frac{\text{Total activity of } R_n}{A_1(R_n)}$$

Where $A_1 (R_1, R_2 \dots R_n)$ is the value of A_1 or A_2 as appropriate for the nuclide $R_1, R_2 \dots R_n$.

(4) When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the formula given in subparagraph (3) of this paragraph must be applied to establish the values

of A₁ or A₂ as appropriate. All the radionuclides whose individual activities are not known (but whose total activity is known) must be classed in a single group and the most restrictive value of A₁ or A₂ applicable to any one of them shall be used as the value of A₁ and A₂ in the denominator of the fraction.

(5) When the identity of each radionuclide is known but the individual activity of the radionuclides is not known, the most restrictive value of A₁ or A₂ applicable to any one of the radionuclides present is the applicable value.

(6) When the identity of the radionuclides is not known, the value of A₁ is 2 curies and the value of A₂ is 0.002 curies. However, if alpha emitters are known to be absent, the value of A₂ is 0.4 curies.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983; 48 FR 13432, Mar. 31, 1983, as amended at 48 FR 31218, July 7, 1983; Amdt. 173-185, 50 FR 11055, Mar. 19, 1985]

§ 173.434 Activity-mass relationships for uranium and natural thorium.¹

Radioactive material	Curies per gram	Grams per curie
Uranium—(Wt% ²³⁵ U present):		
0.45	5.0 × 10 ⁻⁷	2.0 × 10 ⁶
0.72 (natural)	7.06 × 10 ⁻⁷	1.42 × 10 ⁶
1.0	7.6 × 10 ⁻⁷	1.3 × 10 ⁶
1.5	1.0 × 10 ⁻⁶	1.0 × 10 ⁶
5.0	2.7 × 10 ⁻⁶	3.7 × 10 ⁵
10.0	4.8 × 10 ⁻⁶	2.1 × 10 ⁵
20.0	1.0 × 10 ⁻⁵	1.0 × 10 ⁵
35.0	2.0 × 10 ⁻⁵	5.0 × 10 ⁴
50.0	2.5 × 10 ⁻⁵	4.0 × 10 ⁴
90.0	5.8 × 10 ⁻⁵	1.7 × 10 ⁴
93.0	7.0 × 10 ⁻⁵	1.4 × 10 ⁴
95.0	9.1 × 10 ⁻⁵	1.1 × 10 ⁴
Natural thorium.	2.2 × 10 ⁻⁷	4.6 × 10 ⁶

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

§ 173.435 Table of A₁ and A₂ values for radionuclides.

Symbol of radionuclide	Element and atomic number	A ₁ (Ci) special form	A ₂ (Ci) normal form
227 _{Ac}	Actinium (89)	1000	0.003
228 _{Ac}		10	4
105 _{Ag}	Silver (47)	40	40
110 _{mAg}		7	7
111 _{Ag}		100	20
241 _{Am}	Americium (95) ¹	8	0.008
243 _{Am}		8	0.008
37 _{Ar} (compressed or uncompressed)	Argon (18)	1000	1000
41 _{Ar} (uncompressed)		20	20
41 _{Ar} (compressed)		1	1
73 _{As}	Arsenic (33)	1000	400
74 _{As}		20	20
76 _{As}		10	10
77 _{As}		300	20
211 _{At}	Astatine (85)	200	7
193 _{Au}	Gold (79)	200	200
196 _{Au}		30	30
198 _{Au}		40	20
199 _{Au}		200	25
131 _{Ba}	Barium (56)	40	40
133 _{Ba}		40	10
140 _{Ba}		20	20
7 _{Be}	Beryllium (4)	300	300
206 _{Bi}	Bismuth (83)	5	5
207 _{Bi}		10	10
210 _{Bi} (RaE)		100	4
212 _{Bi}		6	6
249 _{Bk}	Berkelium (97)	1000	1
77 _{Br}	Bromine (35)	70	25
82 _{Br}		6	6
11 _C	Carbon (6)	20	20
14 _C		1000	60
45 _{Ca}	Calcium (20)	1000	25
47 _{Ca}		20	20
109 _{Cd}	Cadmium (48)	1000	70
115 _{mCd}		30	30
115 _{Cd}		80	20
139 _{Ce}	Cerium (58)	100	100
141 _{Ce}		300	25
143 _{Ce}		60	20
144 _{Ce}		10	7
249 _{Cf}	Californium (98)	2	0.002
250 _{Cf}		7	0.007
252 _{Cf}		2	0.009
36 _{Cl}	Chlorine (17)	300	10

Symbol of radionuclide	Element and atomic number
38 _{Ci}	Curium
242 _{Cm}	
243 _{Cm}	
244 _{Cm}	
245 _{Cm}	
246 _{Cm}	
56 _{Co}	Cobalt
57 _{Co}	
58 _{mCo}	
58 _{Co}	
60 _{Co}	
51 _{Cr}	Chromium (24)
129 _{Cs}	Cesium
131 _{Cs}	
134 _{mCs}	
134 _{Cs}	
135 _{Cs}	
136 _{Cs}	
137 _{Cs}	
64 _{Cu}	Copper
67 _{Cu}	
165 _{Dy}	Dysprosium (66)
166 _{Dy}	
169 _{Er}	Erbium
171 _{Er}	
152 _{mEu}	Europium (63)
152 _{Eu}	
154 _{Eu}	
155 _{Eu}	
18 _F	Fluorine
52 _{Fe}	Iron (26)
55 _{Fe}	
59 _{Fe}	
67 _{Ga}	Gallium
68 _{Ga}	
72 _{Ga}	
153 _{Gd}	Gadolinium (64)
159 _{Gd}	
68 _{Ge}	Germanium (32)
71 _{Ge}	
3 _H	Hydrogen (1) See T-Tritium
181 _{Hf}	Hafnium (72)
197 _{mHg}	Mercury (80)
197 _{Hg}	
203 _{Hg}	
166 _{Ho}	Holmium (67)
123 _I	Iodine (53)
125 _I	
126 _I	
129 _I	
131 _I	
132 _I	
133 _I	
134 _I	
135 _I	
111 _{In}	Indium (49)
113 _{mIn}	
114 _{mIn}	
115 _{mIn}	
190 _{Ir}	Iridium (77)
192 _{Ir}	

Symbol of radionuclide	Element and atomic number	A ₁ (Ci) special form	A ₂ (Ci) normal form	Symbol of radionuclide	Element and atomic number	A ₁ (Ci) special form	A ₂ (Ci) normal form
38Cf	Curium (96)	10	10	194Ir	...	10	10
242Cm	Curium (96)	200	0 2	42K	Potassium (19)	10	10
243Cm	...	9	0 009	43K	...	20	10
244Cm	...	10	0 01	85Kr	Krypton (36)	100	100
245Cm	...	6	0 006	(uncompressed)	...	3	3
246Cm	...	6	0 006	35mKr	...	1000	1000
56Co	Cobalt (27)	5	5	(compressed)	...	5	5
57Co	...	90	90	85Kr	...	1000	1000
58mCo	...	1000	1000	(uncompressed)	...	5	5
58Co	...	20	20	85Kr	...	20	20
60Co	...	7	7	(compressed)	...	0 6	0 6
51Cr	Chromium (24)	600	600	87Kr	...	0 6	0 6
129Cs	Cesium (55)	40	40	87Kr	...	30	30
131Cs	...	1000	1000	(uncompressed)	...	300	25
134mCs	...	1000	1000	87Kr	...	10	0 4
134Cs	...	10	10	(compressed)	...	6	6
135Cs	...	1000	25	87Kr	...	5	5
136Cs	...	7	7	(uncompressed)	...	100	20
137Cs	...	30	10	87Kr	...	20	20
64Cu	Copper (29)	80	25	(compressed)	...	8	8
67Cu	...	200	25	140La	Lanthanum (57)	5	5
165Dy	Dysprosium (66)	100	20	...	Low specific activity material—see § 173.403	20	20
166Dy	...	1000	260	177Lu	Lutetium (71)	300	25
169Er	Erbium (68)	1000	25	...	Mixed fission products	10	0 4
171Er	...	50	20	20Mg	Magnesium (12)	6	6
152mEu	Europium (63)	30	10	52Mn	Manganese (25)	5	5
152Eu	...	20	10	54Mn	...	20	20
154Eu	...	10	5	56Mn	...	5	5
155Eu	...	400	60	99Mo	Molybdenum (42)	100	20
18F	Flourine (9)	20	20	13N	Nitrogen (7)	20	10
52Fe	Iron (26)	5	5	22Na	Sodium (11)	8	8
55Fe	...	1000	1000	24Na	...	5	5
59Fe	...	10	10	93mNb	Niobium (41)	1000	200
67Ga	Gallium (31)	100	100	95mNb	...	20	20
68Ga	...	20	20	97mNb	...	20	20
72Ga	...	7	7	147Nd	Neodymium (60)	100	20
153Gd	Gadolinium (64)	200	100	149Nd	...	30	20
159Gd	...	300	20	59Ni	Nickel (28)	1000	900
68Ge	Germanium (32)	20	10	63Ni	...	1000	100
71Ge	...	1000	1000	65Ni	...	10	10
3H	Hydrogen (1) See T-Tritium	...	...	237Np	Neptunium (93)	5	0 005
181Hf	Hafnium (72)	30	25	239Np	...	200	25
197mHg	Mercury (80)	200	200	185Pt	Osmium (76)	20	20
197Hg	...	200	200	191Pt	...	600	200
203Hg	...	80	25	191mPt	...	200	200
166Ho	Holmium (67)	30	20	193Pt	...	100	20
123I	Iodine (53)	50	20	32P	Phosphorus (15)	30	30
125I	...	1000	10	230Pa	Protactinium (91)	20	0 8
126I	...	40	10	231Pa	...	2	0 002
129I	...	1000	2	233Pa	...	100	100
131I	...	40	10	201Pb	Lead (82)	20	20
132I	...	7	7	210Pb	...	100	0 2
133I	...	30	10	...	...	...	...
134I	...	8	8	...	...	...	...
135I	...	10	10	...	...	...	...
111In	Indium (49)	30	25	...	...	...	...
113mIn	...	60	60	...	...	...	...
114mIn	...	30	20	...	...	...	...
115mIn	...	100	25	...	...	...	...
190Ir	Iridium (77)	10	10	...	...	...	...
192Ir	...	20	10	...	...	...	...

Symbol of radionuclide	Element and atomic number	A ₁ (Ci) special form	A ₂ (Ci) normal form	Symbol of radionuclide	Element and atomic number	A ₁ (Ci) special form	A ₂ (Ci) normal form
212 _{Pb}		6	5	91 _{Sr}		10	10
103 _{Pd}	Palladium, (46)	1000	700	92 _{Sr}		10	10
109 _{Pd}		100	20	T	Tritium (1)	1000	1000
147 _{Pm}	Promethium (61)	1000	25		(uncompressed)		
149 _{Pm}		100	20	T	(compressed)	1000	1000
210 _{Po}	Polonium (84)	200	0.2		(activated luminous paint)		
142 _{Pr}	Praseodymium (59)	10	10	T	(adsorbed on solid carrier)	1000	1000
143 _{Pr}		300	20		(tritiated water)		
191 _{Pt}	Platinum (78)	100	100	T	(other forms)	20	20
193 _{Pt}		200	200	182 _{Ta}	Tantalum (73)	20	20
197 _{Pt}		300	20	160 _{Tb}	Terbium (65)	20	10
197 _{Pt}		300	20	96 _{Tc}	Technetium (43)	1000	1000
238 _{Pu}	Plutonium (94) ¹	3	0.003	97 _{Tc}		6	6
239 _{Pu}		2	0.002	99 _{Tc}		1000	200
240 _{Pu}		2	0.002	97 _{Tc}		1000	400
241 _{Pu}		1000	0.1	99 _{Tc}		100	100
242 _{Pu}		3	0.003	99 _{Tc}		1000	25
223 _{Ra}	Radium (88)	50	0.2	125 _{Te}	Tellurium (52)	1000	100
224 _{Ra}		6	0.5	127 _{Te}		300	20
226 _{Ra}		10	0.05	127 _{Te}		300	20
228 _{Ra}		10	0.05	129 _{Te}		30	10
81 _{Rb}	Rubidium (37)	30	25	129 _{Te}		100	20
86 _{Rb}		30	30	131 _{Te}		10	10
87 _{Rb}		Unlimited	Unlimited	132 _{Te}		7	7
Rb (natural)		Unlimited	Unlimited	227 _{Th}	Thorium (90)	200	0.2
186 _{Re}	Rhenium (75)	100	20	228 _{Th}		6	0.008
187 _{Re}		Unlimited	Unlimited	230 _{Th}		3	0.003
188 _{Re}		10	10	231 _{Th}		1000	25
Re (natural)		Unlimited	Unlimited	232 _{Th}		Unlimited	Unlimited
103 _{Rh}	Rhodium (45)	1000	1000	234 _{Th}		10	10
105 _{Rh}		200	25	Th	(natural)	Unlimited	Unlimited
222 _{Rn}	Radon (86)	10	2	Th	(irradiated) ²		
97 _{Ru}	Ruthenium (44)	80	80	200 _{Tl}	Thallium (81)	20	20
103 _{Ru}		30	25	201 _{Tl}		200	200
105 _{Ru}		20	20	202 _{Tl}		40	40
106 _{Ru}		10	7	204 _{Tl}		300	10
35 _S	Sulphur (16)	1000	60	170 _{Tm}	Thulium (69)	300	10
122 _{Sb}	Antimony (51)	30	30	171 _{Tm}		1000	100
124 _{Sb}		5	5	230 _U	Uranium (92)	100	0.1
125 _{Sb}		40	25	232 _U		30	0.03
46 _{Sc}	Scandium (21)	8	8	233 _U		100	0.1
47 _{Sc}		200	20	234 _U		100	0.1
48 _{Sc}		5	5	235 _U		100	0.2
75 _{Se}	Selenium (34)	40	40	236 _U		200	0.2
31 _{Si}	Silicon (14)	100	20	238 _U		Unlimited	Unlimited
147 _{Sm}	Samarium (62)	Unlimited	Unlimited		(natural)	Unlimited	Unlimited
151 _{Sm}		1000	90		(enriched)		
153 _{Sm}		300	20				
113 _{Sn}	Tin (50)	60	60				
119 _{Sn}		100	100				
125 _{Sn}		10	10				
85 _{Sr}	Strontium (38)	80	80				
85 _{Sr}		30	30				
87 _{Sr}		50	50				
89 _{Sr}		100	10				
90 _{Sr}		10	0.4				

Symbol of radionuclide	Element and atomic number
<20%	
20% or greater	
u (depleted)	
u (irradiated) ³	
48 _V	Vanadium (23)
181 _W	Tungsten (74)
185 _W	
187 _W	
127 _{Xe}	Xenon (54)
(uncompressed)	
127 _{Xe}	
(compressed)	
131 _{Xe}	
(compressed)	
131 _{Xe}	
(uncompressed)	
133 _{Xe}	
(uncompressed)	
133 _{Xe}	
(compressed)	
135 _{Xe}	
(uncompressed)	
135 _{Xe}	
(compressed)	
87 _Y	Yttrium (39)
90 _Y	
91 _Y	
91 _Y	
92 _Y	
93 _Y	
169 _{Yb}	Ytterbium (70)
175 _{Yb}	
65 _{Zn}	Zinc (30)
69 _{Zn}	
69 _{Zn}	
93 _{Zr}	Zirconium (40)
95 _{Zr}	
97 _{Zr}	

¹ For shipments solely value is 20 curies for americium-beryllium or plutonium-beryllium neutron pacemakers

² The values of A₁ and A₂ are in accordance with the procedure in this subchapter, taking into account the products and of the uranium and thorium.

³ The values of A₁ and A₂ are in accordance with the procedure in this subchapter, taking into account the products and plutonium is uranium.

[Amdt. 173-162, 48 FR 13432, Mar.

48 FR 31219, July 7, 1983; Amdt. 173-207, 53 FR 38274, Sept. 29, 1988]

Symbol of radionuclide	Element and atomic number	A ₁ (Ci) special form	A ₂ (Ci) normal form
<20%		Unlimited	Unlimited
20% or greater		100	0.1
^u (depleted)		Unlimited	Unlimited
^u (irradiated) ¹			
48 _v	Vanadium (23)	6	6
181 _w	Tungsten (74)	200	100
185 _w		1000	25
187 _w		40	20
127 _{x_e} (uncompressed)	Xenon (54)	70	70
127 _{x_e} (compressed)		5	5
131 _{m_{x_e}} (compressed)		10	10
131 _{m_{x_e}} (uncompressed)		100	100
133 _{x_e} (uncompressed)		1000	1000
133 _{x_e} (compressed)		5	5
135 _{x_e} (uncompressed)		70	70
135 _{x_e} (compressed)		2	2
87 _y	Yttrium (39)	20	20
90 _y		10	10
91 _{m_y}		30	30
91 _y		30	30
92 _y		10	10
93 _y		10	10
169 _{y_b}	Ytterbium (70)	80	80
175 _{y_b}		400	25
65 _{z_n}	Zinc (30)	30	30
69 _{m_{z_n}}		40	20
69 _{z_n}		300	20
93 _{z_r}	Zirconium (40)	1000	200
95 _{z_r}		20	20
97 _{z_r}		20	20

§ 173.441 Radiation level limitations.

(a) Except as provided in paragraph (b) of this section, each package of radioactive materials offered for transportation shall be designed and prepared for shipment so that under conditions normally incident to transportation the radiation level does not exceed 200 millirem per hour at any point on the external surface of the package, and the transport index does not exceed 10.

(b) A package which exceeds the radiation level limits specified in paragraph (a) of this section shall be transported by exclusive use shipment only and the radiation levels for such shipment must not exceed the following during transportation:

(1) 200 millirem per hour (2 millisievert per hour) on the external surface of the package unless the following conditions are met, in which case the limit is 1000 millirem per hour (10 millisievert per hour).

(i) The shipment is made in a closed transport vehicle;

(ii) The package is secured within the vehicle so that its position remains fixed during transportation; and

(iii) There are no loading or unloading operations between the beginning and end of the transportation;

(2) 200 millirem per hour (2 millisievert per hour) at any point on the outer surfaces of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load (or enclosure is used), and on the lower external surface of the vehicle;

(3) 10 millirem per hour (0.1 millisievert per hour) at any point 2 meters (6.6 feet) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2 meters (6.6 feet) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle); and

(4) 2 millirem per hour (0.02 millisievert per hour) in any normally occupied space, except that this provision

¹ For shipments solely within the United States the A₁ value is 20 curies for americium and plutonium contained in Am-Be or Pu-Be neutron sources or in nuclear-powered pacemakers.

² The values of A₁ and A₂ must be calculated in accordance with the procedure specified in § 173.433 of this subchapter, taking into account the activity of the fission products and of the uranium-233 in addition to that of the thorium.

³ The values of A₁ and A₂ must be calculated in accordance with the procedure specified in § 173.433 of this subchapter, taking into account the activity of the fission products and plutonium isotopes in addition to that of the uranium.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983; 48 FR 13432, Mar. 31, 1983, as amended at

does not apply to private carriers if exposed personnel under their control wear radiation dosimetry devices and operate under provisions of a State or Federally regulated radiation protection program.

(c) For shipments made under the provisions of paragraph (b) of this section, the shipper shall provide specific written instructions for maintenance of the exclusive use shipment controls to the carrier. The instructions shall be included with the shipping paper information.

(d) Packages exceeding the radiation level or transport index prescribed in paragraph (a) of this section shall not be transported by aircraft.

(e) The written instructions required for exclusive use shipments must be sufficient so that, when followed, they will cause the carrier to avoid actions which will unnecessarily delay delivery or unnecessarily result in increased radiation levels or radiation exposures.

(The information collection requirements contained in paragraph (c) were approved by the Office of Management and Budget under control number 2137-0536)

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983; Amdt. 173-193, 50 FR 41898, Oct. 16, 1985]

§ 173.442 Thermal limitations.

Each package of radioactive material shall be designed, constructed, and loaded so that:

(a) The heat generated within the package because of the radioactive contents will not, at any time during transportation, affect the integrity of the package under conditions normally incident to transportation; and

(b) The temperature of the accessible external surfaces of the loaded package will not, assuming still air in the shade at an ambient temperature of 38° C (100° F), exceed either:

(1) 50° C (122° F) in other than an exclusive use shipment; or

(2) 82° C (180° F) in an exclusive use shipment.

§ 173.443 Contamination control.

(a) The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment shall be kept as low

as practicable. The level of non-fixed radioactive contamination may be determined by wiping an area of 300 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements shall be taken in the most appropriate locations to yield a representative assessment of the non-fixed contamination levels. Except as provided in paragraph (b) of this section, the amount of radioactivity measured on any single wiping material when averaged over the surface wiped shall not exceed the limits given in Table 10 at any time during transport. Other methods of assessment of equal or greater efficiency may be used. When other methods are used the detection efficiency of the method used shall be taken into account and in no case shall the non-fixed contamination on the external surfaces of the package exceed ten times the limits listed in Table 10.

TABLE 10—REMOVABLE EXTERNAL RADIOACTIVE CONTAMINATION—WIPE LIMITS

Contaminant	Maximum permissible limits	
	uCi/cm ²	dpm/cm ²
Beta-gamma emitting radionuclides; all radionuclides with half-lives less than ten days; natural uranium; natural thorium; uranium-235; uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical concentrates	10 ⁻⁵	22
All other alpha emitting radionuclides.	10 ⁻⁶	2.2

(b) Except as provided in paragraph (d) of this section, in the case of packages transported as exclusive use shipments by rail or public highway only, the removable (non-fixed) radioactive contamination on any package at any time during transport shall not exceed ten times the levels prescribed in paragraph (a) of this section. The levels at the beginning of transport shall not exceed the levels prescribed in paragraph (a) of this section.

(c) Except as provided in paragraph (d) of this section, each transport vehicle used for transporting radioactive

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(3) Each vt
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[Amdt. 173-162, 4
as amended at 48

§ 173.444 Labelin
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§ 173.427 shall t
in subpart E of
chapter.

§ 173.446 Placard
See subpart F
chapter.

§ 173.447 Storage
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materials as an exclusive use shipment which utilizes the provisions of paragraph (b) of this section shall be surveyed with appropriate radiation detection instruments after each use. A vehicle shall not be returned to service until the radiation dose rate at each accessible surface is 0.5 millirem per hour or less, and there is no significant removable (non-fixed) radioactive surface contamination as specified in paragraph (a) of this section.

(d) Paragraph (b) and (c) of this section do not apply to any closed transport vehicle used solely for the transportation by public highway of radioactive material packages with contamination levels that do not exceed 10 times the levels prescribed in paragraph (a) of this section if:

(1) A survey of the interior surfaces of the empty vehicle shows that the radiation dose rate at any point does not exceed 10 millirem per hour at the surface or 2 millirem per hour at 1 meter (3.3 feet) from the surface;

(2) Each vehicle is stenciled with the words "For Radioactive Materials Use Only" in letters at least 76 millimeters (3 inches) high in a conspicuous place on both sides of the exterior of the vehicle; and

(3) Each vehicle is kept closed except for loading or unloading.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983]

§ 173.444 Labeling requirements.

Each package of radioactive materials, unless excepted by § 173.421, § 173.422, § 173.424, § 173.425(b), or § 173.427 shall be labeled as provided in subpart E of part 172 of this subchapter.

§ 173.446 Placarding requirements.

See subpart F of part 172 of this subchapter.

§ 173.447 Storage incident to transportation—general requirements.

The following requirements apply to temporary storage during the course of transportation but not to Nuclear Regulatory Commission or Agreement State licensed facilities or U.S. Government owned or contracted facilities.

(a) The number of packages bearing Radioactive Yellow II or Radioactive Yellow III labels stored in any one storage area, such as a transit area, terminal building, store-room, or assembly yard, shall be limited so that the sum of the transport indexes in any individual group of packages does not exceed 50. Groups of these packages must be stored so as to maintain a spacing of at least 6 meters (20 feet) from other groups of packages containing radioactive materials.

(b) Mixing of different kinds of packages, including Fissile Class I packages with Fissile Class II packages, is authorized in accordance with § 173.459 of this subchapter.

§ 173.448 General transportation requirements.

(a) Each shipment of radioactive materials shall be secured in order to prevent shifting during normal transportation conditions.

(b) Except as may be specifically required by the competent authority in the applicable certificate, a package of 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 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 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, including Fissile Class I packages with Fissile Class II packages, is authorized in accordance with § 173.459.

(e) No person shall offer for transportation aboard a passenger-carrying aircraft any single package with a transport index greater than 3.0 or an

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overpack with a transport index greater than 3.0.

(f) No person shall offer for transportation aboard a passenger-carrying aircraft any radioactive material unless that material is intended for use in, or incident to, research, medical diagnosis or treatment.

(g) If an overpack is used to consolidate individual packages of radioactive materials, the packages shall comply with the packaging, marking, and labeling requirements of this subchapter, and the following:

(i) The overpack shall be labeled as prescribed in § 172.403 of this subchapter except as follows:

(i) The "contents" entry on the label may state "mixed" unless each inside package contains the same radionuclide(s).

(ii) The "activity" entry on the label must be determined by adding together the number of curies of the radioactive materials packages contained therein.

(iii) For a non-rigid overpack, the required label together with required package markings shall be affixed to the overpack by means of a securely attached, durable tag. The transport index shall be determined by adding together the transport indexes of the radioactive materials packages contained therein.

(iv) For a rigid overpack, the transport index shall be determined by:

(A) Adding together the transport indexes of the radioactive materials packages contained in the overpack; or

(B) Except for fissile radioactive materials, direct measurements as prescribed in § 173.403(bb) which have been taken by the person initially offering the packages contained within the overpack for shipment.

(2) The overpack shall be marked as prescribed in subpart D of part 172 of this subchapter and § 173.25(a).

(3) The transport index of the overpack shall not exceed 3.0 for passenger-carrying aircraft shipments, or 10.0 for cargo-aircraft only shipments.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended by Amdt. 173-167, 48 FR 30138, June 30, 1983; Amdt. 173-162, 48 FR 31219, July 7, 1983; Amdt. 173-16, 48 FR 50461, Nov. 1, 1983; Amdt. 173-187, 50 FR 21051, May 22, 1985]

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§ 173.451 Fissile materials—general requirements.

(a) Except as provided in § 173.453, each package containing fissile radioactive materials must comply with §§ 173.451 through 173.459.

§ 173.453 Fissile materials—exceptions.

The requirements of §§ 173.451 through 173.459 do not apply to:

(a) A package containing not more than 15 grams of fissile radionuclides. If the material is transported in bulk, the quantity limitation applies to the conveyance;

(b) A package containing irradiated natural or depleted uranium including the products of irradiation if the irradiation has taken place only in the thermal reactor;

(c) A package containing homogeneous solutions or mixtures where:

(1) The minimum ratio of the number of hydrogen atoms to the number of atoms of fissile radionuclides (H/X) is 5200;

(2) The maximum concentration of fissile radionuclides is 5 grams per liter; and

(3) The maximum mass of fissile radionuclides in the package is 500 grams, except for a mixture where the total mass of plutonium and uranium-233 does not exceed 1% of the mass of uranium-235 the limit is 800 grams. If the material is transported in bulk, the quantity limitations apply to the conveyance;

(d) A package containing uranium enriched in uranium-235 to a maximum of 1% by weight, and with a total plutonium and uranium-233 content of up to 1% of the mass of uranium-235, if the fissile radionuclides are distributed homogeneously throughout the package contents, and do not form a lattice arrangement within the package;

(e) A package containing any fissile material if it does not contain more than 5 grams of fissile radionuclides in any 10-liter volume, and if the material is packaged so as to maintain this limit of fissile radionuclide concentration during normal transport;

(f) A package containing not more than one kilogram of plutonium of which not more than 20% by mass

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may consist of um-241, or any radionuclides;

(g) A package of uranium-235 to a weight, with total mass of uranium-233 not more than 10% of the mass of uranium-235;

(h) A package of uranium with not more than 10% weight of fissile radionuclides for shipment solely in the United States.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 10226, Mar. 10, 1983]

§ 173.455 Classific packages.

(a) Except as provided in this section, each package of fissile material shall be classified as follows:

(1) *Fissile Class I* packages may be transported in bulk, and in a quantity that require no nuclear safety controls during transport. A transport index of 50. For the purposes of nuclear safety control, although, the levels may require a transport index number.

(2) *Fissile Class II* packages may be transported in bulk, but in a quantity that exceed an aggregate transport index of 50. For the purposes of nuclear safety control, although, the levels may require a transport index number. They require no nuclear safety control by the shipper.

(3) *Fissile Class III* packages of fissile material that do not meet the requirements of *Fissile Class I* or *Fissile Class II* shall be controlled in transport in accordance with the requirements prescribed in § 173.457 for packages between the carrier and the recipient.

(b) The numerical transport index assignments as prescribed in § 173.457 for packages, and the criticality safety control levels for packages, shall be determined by the shipper.

may consist of plutonium-239, plutonium-241, or any combination of those radionuclides;

(g) A package containing liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by weight, with total plutonium and uranium-233 not more than 0.1% of the mass of uranium-235; or

(h) A package containing thorium or uranium with not more than 0.72% by weight of fissile material used for shipment solely within the United States.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983]

§ 173.455 Classification of fissile materials packages.

(a) Except as provided in § 173.453, each package of fissile materials shall be classified as follows:

(1) *Fissile Class I.* Packages that may be transported in unlimited number, and in any arrangement, and that require no nuclear criticality safety controls during transportation. A transport index is not assigned to Fissile Class I packages for the purposes of nuclear criticality safety control, although, the external radiation levels may require a transport index number.

(2) *Fissile Class II.* Packages that may be transported together in any arrangement but in numbers that do not exceed an aggregate transport index of 50. For the purposes of nuclear criticality safety control, individual packages may have a transport index of not less than 0.1 and not more than 10. However, the external radiation levels may require a higher transport index number. These shipments require no nuclear criticality safety control by the shipper during transportation.

(3) *Fissile Class III.* Shipments of packages of fissile materials that do not meet the requirements of Fissile Class I or Fissile Class II and that are controlled in transportation as prescribed in § 173.457 by appropriate arrangements between the shipper and the carrier.

(b) The numerical values for package assignments as Fissile Class I, the transport indexes for Fissile Class II packages, and the conveyance and ve-

hicle limitations for Fissile Class III shipments shall be determined in accordance with 10 CFR part 71.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983]

§ 173.457 Transportation of Fissile Class III shipments-specific requirements.

(a) Fissile Class III shipments shall incorporate transportation controls which are performed by the shipper or carrier, as appropriate, and which:

(1) Provide nuclear criticality safety;

(2) Protect against loading, storing, or transporting that shipment with any other fissile material; and

(3) Include in the shipping papers the description required by § 172.203(d) of this subchapter.

(b) Fissile Class III shipments shall be transported:

(1) In a conveyance (transport vehicle if transported by public highway or rail) assigned to the exclusive use of the shipper with a specific restriction for the exclusive use to be provided in the appropriate arrangements between shipper and carrier and with instructions to that effect issued with the shipping papers;

(2) Except for shipments by aircraft, with an escort in a vehicle having the capability, equipment, authority, and instructions to provide administrative controls necessary to assure compliance with this section;

(3) In a conveyance (transport vehicle if transported by public highway or rail) containing no other packages of radioactive material that are required to bear one of the labels prescribed in § 172.403 of this subchapter. Specific arrangements must be made between the shipper and the carrier, with instructions to that effect issued with the shipping papers; or

(4) Under any other procedure specifically authorized by the Associate Administrator for Hazardous Materials Safety in accordance with part 107 of this subchapter.

(The information collection requirements contained in paragraph (b) were approved by the Office of Management and Budget under control number 2137-0535)

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983,

and amended by Amdt. 173-224, 56 FR 66279, Dec. 20, 1991]

§ 173.459 Mixing of fissile material packages.

Shipments of fissile materials packages and the commingling of fissile materials packages with other radioactive materials packages shall be in accordance with the provisions of this section.

(a) Mixing of fissile material packages with other types of radioactive materials, including Fissile Class I with Fissile Class II packages is authorized if the total transport index in any conveyance (transport vehicle if transported by public highway or rail) or storage location does not exceed 50.

(b) For Fissile Class II packages shipped under the exclusive use provisions of § 173.441(b), the transport index number which is calculated for nuclear criticality control purposes shall not exceed 10 for any single package nor a total of 50 for the conveyance (transport vehicle if transported by public highway or rail).

(c) Fissile Class II packages may be shipped with an external radiation level greater than 10 millirem per hour at 1 meter (3.3 feet), and combined with other packages of the same or different designs in a Fissile Class III shipment, under the conditions prescribed in § 173.457, if:

(1) Each package in the shipment has been assigned a transport index for criticality control purposes in accordance with the Fissile Class II criteria;

(2) The transport index which has been assigned in the package approval for nuclear criticality control purposes does not exceed 10 for any single package;

(3) The total transport index for nuclear criticality control purposes does not exceed 100 for all packages in the shipment;

(4) The shipment complies with § 173.441(b); and

(5) The shipment is not transported by vessel.

(d) A Fissile Class III shipment of packages may be combined with other packages of the same or different design when each package has been assigned a transport index for nuclear

criticality control purposes in accordance with Fissile Class II criteria, and may be combined with Fissile Class II packages into a Fissile Class III shipment under the conditions prescribed in § 173.457, if:

(1) The transport index which has been assigned in the package approval for nuclear criticality control purposes does not exceed 50 for any single package;

(2) The total transport index for nuclear criticality control purposes for all packages in the shipment does not exceed 100;

(3) The shipment satisfies the provisions of § 173.441(b) if any package has a radiation level exceeding 10 millirem per hour at 1 meter (3.3 feet) from any accessible external surface of the package; and

(4) The shipment is not transported by vessel.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983]

§ 173.461 Demonstration of compliance with tests.

(a) Compliance with the test requirements in §§ 173.463 through 173.469 shall be shown by any of the methods prescribed in this paragraph, or by a combination of these methods appropriate for the particular feature being evaluated:

(1) By performance of tests with prototypes or samples of the packaging or special form material as normally presented for transportation, in which case the contents of the packaging for the test shall simulate as closely as practicable the expected normal radioactive contents. The use of non-radioactive substitute contents is encouraged provided that the results of the testing take into account the radioactive characteristics of the contents for which it is being tested;

(2) By reference to a previous, satisfactory demonstration of compliance of a sufficiently similar nature;

(3) By performance of tests with models of appropriate scale incorporating those features that are significant with respect to the item under investigation, when engineering experience has shown results of those tests to be suitable for design purposes.

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When a scale for adjusting such as the per cent compressive load account; or

(4) By engineering comparative data

(b) With respect to the immersion test through 173.46 based upon the package is in element temperature

[Amdt. 173-162, 48 FR 31219, July 7, 1983]

§ 173.462 Preparation for testing.

(a) Each specimen or scale defined before test record faults or conditions

(1) Divergence of test results or drawings

(2) Defects in construction or

(3) Corrosion of and

(4) Distortion of

(b) Any deviation from the design graph (a) of the specified design suitably taken into account in subsequent evaluation

(c) The container or packaging shall be tested

(d) The external surface of the specimen shall be tested that reference material is a part of it.

§ 173.463 Packaging for integrity.

After each of the tests specified in §§ 173.463 through 173.469, the integrity of the packaging and its contents shall be retained to the extent specified in § 173.412(m) for the tests tested.

§ 173.465 Type A packaging.

(a) The proposed contents of the packaging notwithstanding the tests prescribed in this section. One test shall be used for all tests if the results of paragraph (b) of this section complied with.

When a scale model is used, the need for adjusting certain test parameters, such as the penetrator diameter or the compressive load, must be taken into account; or

(4) By engineering evaluation or comparative data.

(b) With respect to the initial conditions for the tests under §§ 173.463 through 173.469, except for the water immersion tests, compliance shall be based upon the assumption that the package is in equilibrium at an ambient temperature of 38°C (100°F).

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983]

§ 173.462 Preparation of specimens for testing.

(a) Each specimen (i.e., sample, prototype or scale model) shall be examined before testing to identify and record faults or damage, including:

- (1) Divergence from the specifications or drawings;
- (2) Defects in construction;
- (3) Corrosion or other deterioration; and
- (4) Distortion of features.

(b) Any deviation found under paragraph (a) of this section from the specified design shall be corrected or suitably taken into account in the subsequent evaluation.

(c) The containment system of the packaging shall be clearly specified.

(d) The external features of the specimen shall be clearly identified so that reference may be made to any part of it.

§ 173.463 Packaging and shielding—testing for integrity.

After each of the applicable tests specified in §§ 173.465 and 173.466, the integrity of the packaging, or of the packaging and its shielding, shall be retained to the extent required by § 173.412(m) for the packaging being tested.

§ 173.465 Type A packaging tests.

(a) The proposed packaging with proposed contents must be capable of withstanding the tests prescribed in this section. One prototype may be used for all tests if the requirements of paragraph (b) of this section are complied with.

(b) *Water spray test.* The water spray test must precede each test or test sequence prescribed in this section. The water spray test shall 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 shall 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.

(c) *Free drop test.* The free drop test consists of a fall onto the target in a manner that causes maximum damage to the safety features being tested, and:

(1) For packages weighing 5,000 kilograms (11,000) pounds) or less, the distance of the fall measured from the lowest point of the packaging to the upper surface of the target shall not be less than 1.2 meters (4 feet).

(2) For packages weighing more than 5,000 kilograms (11,000 pounds), the distance of the fall shall not be less than the distance specified in Table 11, for the applicable packaging weight:

TABLE 11—FREE-FALL DISTANCE FOR PACKAGINGS WEIGHING MORE THAN 5,000 KILOGRAMS

Packaging weight		Free-fall distance	
Kilograms	Pounds	Feet	Meters
>5,000 to 10,000	>11,000 to 22,000	3	0.9
>10,000 to 15,000	>22,000 to 33,000	2	0.6
More than 15,000	More than 33,000	1	0.3

(3) For Fissile Class II packagings, the free drop specified in subparagraph (1) or (2) of this paragraph shall be preceded by a free drop from a height of .3 meter (1 foot) on each corner. For cylindrical packagings, the .3 meter (1 foot) drop shall be onto each of the quarters of each rim.

(4) For fiberboard or wood rectangular packages not exceeding 50 kilograms (110 pounds) in weight, a separate specimen of the proposed packaging shall be subjected to a free drop onto each corner from a height of .3 meter (1 foot).

(5) For fiberboard cylindrical packages weighing not more than 100 kilograms (220 pounds) a separate specimen of the proposed packaging shall be subjected to a free drop onto each of the quarters of each rim from a height of .3 meter (1 foot).

(6) The target shall have a flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

(d) *Compression test.* The compression test shall last for a period of at least 24 hours and consists of a compressive load equivalent to the greater of the following:

(1) Five times the weight of the actual package; or

(2) 1300 kilograms per square meter (265 pounds per square foot) multiplied by the vertically projected area of the package. The compressive load shall be applied uniformly to two opposite sides of the packaging specimen, one of which must be the base on which the package would normally stand.

(e) *Penetration test.* For the penetration test the packaging specimen shall be placed on a rigid, flat, horizontal surface that will not move while the test is being performed. The test shall consist of:

(1) A bar of 3.2 centimeters (1.25 inches) in diameter with a hemispherical end, weighing 6 kilograms (13.2 pounds) being dropped with its longitudinal axis vertical, onto the center of the weakest part of the packaging specimen, so that, if it penetrates far enough, it will hit the containment system. The bar must not be deformed by the test; and

(2) The distance of the fall of the bar measured from its lower end to the upper surface of the packaging specimen shall not be less than 1 meter (3.3 feet).

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983; Amdt. 173-16, 48 FR 50461, Nov. 1, 1983; Amdt. 173-196, 51 FR 5973, Feb. 18, 1986; Amdt. 173-224, 56 FR 66279, Dec. 20, 1991]

§ 173.466 Additional tests for Type A packagings designed for liquids and gases.

(a) In addition to the tests prescribed in § 173.465, Type A packagings designed for liquids and gases shall be capable of withstanding the following tests:

(1) *Free drop test.* The packaging specimen shall fall onto the target in a manner which will cause it to suffer the maximum damage to its containment. The distance of the fall measured from the lowest part of the packaging specimen to the upper surface of the target shall be not less than 9 meters (30 feet).

(2) *Penetration test.* The specimen must be subjected to the test specified in § 173.465(e) except that the distance of the fall shall be 1.7 meters (5.5 feet).

§ 173.467 Tests for demonstrating the ability of Type B and fissile radioactive materials packagings to withstand accident conditions in transportation.

Each Type B packaging or packaging for fissile material shall meet the test requirements prescribed in 10 CFR part 71 for ability to withstand accident conditions in transportation.

§ 173.469 Tests for special form radioactive materials.

(a) Special form radioactive materials must meet the test requirements of paragraph (b) of this section. Each solid radioactive material or capsule specimen to be tested shall be manufactured or fabricated so that it is representative of the actual solid material or capsule which will be transported with the proposed radioactive content duplicated as closely as practicable. Any differences between the material to be transported and the test material such as the use of non-radioactive contents shall be taken into account. In addition:

(1) A different specimen may be used for each of the tests;

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(2) The specimen shall not shatter when subjected to a percussion test;

(3) The specimen shall not disperse when subjected to a dispersion test; and

(4) After the test, the specimen shall be indispersible. The test shall be determined by a test sensitive than that prescribed in paragraph (a). For a dispersion test, the specimen shall be dispersed by water into a nominal void volume of 1 liter, an alternate assessment is to determine the tightness of the packaging by measuring the leakage rate in atm-cm³/s at one atmosphere for solids and 10⁻⁶ torr-1/s for liquids or gases.

(b) Test method. The specimen shall be subjected to the test specified in § 173.467(a) from a height of 1.7 meters (30 feet) onto the target specified in § 173.467(a).

(2) Percussion test. The specimen shall be placed on a rigid, flat, horizontal surface supported by a steel billet so that the specimen is subjected to a free fall of 1.7 meters (5.5 feet) through 1 meter (3.3 feet) of water.

(i) The flat surface of the specimen shall be 25 millimeters (1 inch) with the edges of 3 millimeters (1/8 inch) ± .012 inch.

(ii) The lead thickness shall be within 3.5 to 4.5 millimeters (1/8 to 1/4 inch) thick, and not more than 1.5 millimeters (1/16 inch) greater than the thickness of the specimen;

(iv) A fresh specimen shall be used for each impact test.

(v) The specimen shall be placed in a manner that will minimize damage.

(3) Bending test. The specimen shall be bent only to a length of 10 centimeters (4 inches) or more and with a force of not more than five times the minimum force required to bend the specimen.

(ii) The specimen shall be clamped in a manner that will minimize damage.

(2) The specimen must not break or shatter when subjected to the impact, percussion, or bending tests;

(3) The specimen must not melt or disperse when subjected to the heat test; and

(4) After each test, leaktightness or indispersibility of the specimen shall be determined by a method no less sensitive than the leaching assessment prescribed in paragraph (c) of this section. For a capsule resistant to corrosion by water, and which has an internal void volume greater than 0.1 milliliters, an alternative to the leaching assessment is a demonstration of leaktightness of 10^{-4} torr-1/s (1.3×10^{-4} atm-cm³/s) based on air at 25°C (77°F) and one atmosphere differential pressure for solid radioactive content, or 10^{-6} torr-1/s (1.3×10^{-6} atm-cm³/s) for liquid or gaseous radioactive content.

(b) Test methods. (1) Impact Test. The specimen must fall onto the target from a height of not less than 9 meter (30 feet). The target must be as specified in § 173.465(c)(6);

(2) Percussion Test. (i) The specimen shall be placed on a sheet of lead that is supported by a smooth solid surface, and be struck by the flat face of a steel billet so as to produce an impact equivalent to that resulting from a free fall of 1.4 kilograms (3 pounds) through 1 meter (3.3 feet);

(ii) The flat face of the billet shall be 25 millimeters (1 inch) in diameter with the edges rounded off to a radius of 3 millimeters ± 0.3 millimeters (.12 inch $\pm .012$ inch);

(iii) The lead shall be of a hardness within 3.5 to 4.5 on the Vickers scale, and not more than 25 millimeters (1 inch) thick, and shall cover an area greater than that covered by the specimen;

(iv) A fresh surface of lead shall be used for each impact; and

(v) The billet must strike the specimen in a manner that causes maximum damage.

(3) Bending test. (i) This test applies only to long, slender sources with a length of 10 centimeters (4 inches) or more and with a length at least 10 times the minimum width;

(ii) The specimen must be securely clamped in a horizontal position so

that one half of its length protrudes from the face of the clamp;

(iii) The position of the specimen must be such that it will suffer maximum damage when its free end is struck by the flat face of a steel billet;

(iv) The billet must strike the specimen in a manner that produces an impact equivalent to that resulting from a free vertical fall of 1.4 kilograms (3 pounds) through 1 meter (3.3 feet); and

(v) The flat face of the billet must be 25 millimeters (1 inch) in diameter with the edges rounded off to a radius of 3 millimeters ± 0.3 millimeters (.12 inch $\pm .012$ inch).

(4) Heat test. The specimen shall be heated in air to a temperature of not less than 800°C (1472°F), held at that temperature for a period of 10 minutes, and then allowed to cool.

(c) Leaching assessment methods. (1) For indispersible solid material—(i) The specimen shall be immersed for seven days in water at ambient temperature. The water must have a pH of 6-8 and a maximum conductivity of 10 micromho per centimeter at 20°C (68°F);

(ii) The water and specimen shall then be heated to a temperature of $50^\circ\text{C} \pm 5^\circ$ ($122^\circ\text{F} \pm 9^\circ$) and maintained at this temperature for four hours;

(iii) The activity of the water shall then be determined;

(iv) The specimen shall then be stored for at least seven days in still air with humidity not less than 90 percent at 30°C (86°F);

(v) The specimen shall then be immersed in water with the same pH and maximum conductivity specifications as in subparagraph (1)(i) of this paragraph. The water and specimen must be heated to $50^\circ\text{C} \pm 5^\circ$ ($122^\circ\text{F} \pm 9^\circ$) and maintained at that temperature for four hours;

(vi) The activity of the water shall then be determined. The activities determined in subparagraph (1)(iii) and this subparagraph shall not exceed 0.05 microcuries.

(2) For encapsulated material—(i) The specimen shall be immersed in water at ambient temperature. The water must have a pH of 6-8 and a maximum conductivity of 10 micromho per centimeter. The water and

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specimen shall be heated to a temperature of 50°C±5° (122°F±9°) and maintained at this temperature for four hours;

(ii) The activity of the water shall then be determined;

(iii) The specimen shall then be stored for at least seven days in still air at a temperature not less than 30°C (86°F);

(iv) Step (i) shall be repeated; and

(v) The activity of the water shall be determined. The activities determined in paragraph (c)(2)(ii) and this paragraph (c)(2)(v) shall not exceed 0.05 microcuries.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983]

§ 173.471 Requirements for U.S. Nuclear Regulatory Commission approved packages.

In addition to the applicable requirements of the U.S. Nuclear Regulatory Commission (USNRC) and parts 171-177 of this subchapter, any shipper of a Type B, Type B(U), Type B(M), or fissile material package that has been approved by the USNRC in accordance with 10 CFR part 71 shall also comply with the following requirements:

(a) The shipper shall be registered with the USNRC as a party to the approval, and the shipment must be made in compliance with the terms of the approval;

(b) The outside of each package shall be durably and legibly marked with the package identification marking indicated in the USNRC approval;

(c) Each shipping paper related to the shipment of the package shall bear the package identification marking indicated in the USNRC approval;

(d) Before the first export shipment of the package, the shipper shall obtain a U.S. Competent Authority Certificate for that package design or if one has already been issued, the shipper shall register with the U.S. Competent Authority as a user of the certificate. Upon registration as a user of the certificate the shipper will be furnished with a copy of it. The shipper shall then submit a copy of the U.S. Competent Authority Certificate applying to that package design to the national competent authority of each

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country into or through which the package will be transported, unless a copy has already been furnished;

(e) [Reserved]

(f) Each request for a U.S. Competent Authority Certificate as required by the IAEA regulations shall be submitted in writing to the address set forth in paragraph (e) of this section. The request shall be in duplicate and include copies of the applicable USNRC approval and a reproducible drawing showing the make-up of the package. Each request is considered in the order in which it is received. To allow sufficient consideration by the Associate Administrator for Hazardous Materials Safety, requests should be received at least 45 days before the requested effective date; and

(g) Import and export shipments may be made in accordance with § 171.12 of this subchapter.

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2137-0512. The information collection requirements contained in paragraph (d) were approved under control number 2137-0515.)

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983; Amdt. 173-224, 55 FR 52670, Dec. 21, 1990; 56 FR 66279, Dec. 20, 1991]

§ 173.472 Requirements for exporting DOT Specification Type B and fissile packages.

(a) Any shipper who exports a DOT Specification Type B or fissile material package authorized by § 173.416 or § 173.417 shall comply with paragraphs (b) through (f) of this section.

(b) The shipper shall register with the U.S. Competent Authority as a user of the appropriate U.S. Competent Authority Certificate and the shipment shall be made in accordance with the certificate;

(c) The outside of each package must be durably and legibly marked with the package identification marking indicated in the U.S. Competent Authority Certificate;

(d) Each shipping paper related to the shipment of the package must bear the package identification marking indicated in the U.S. Competent Authority Certificate;

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(e) Before the of the package submit a copy of Authority Certificate package design to the competent authority through which transported, unless been furnished;

(f) Import and may be made § 171.12 of this sub

(The information contained in paragraph proved by the Office of Budget under contr

§ 173.473 Requirements for packages.

In addition to requirements of the shipper of a foreign Type B(U), Type B(M) material package for which authority certificate IAEA "Regulations for Transport of Radioactive Safety Series No. 1" with the following

(a) Prior to the such a package of materials into or from the shall:

(1) Have the foreign authority certificate U.S. Competent Authority has been done previously must be in duplicate the information requested VIII of the IAEA regulations which is considered sufficient consideration Administrator for Hazardous Materials Safety, requests at least 45 days before effective date.

(2) Submit a copy of foreign competent authority certificate with the request

(3) Register its information with the U.S. Competent Authority as a user of the package and its revalidation per is requesting the information is automatically done Administrator for Hazardous Materials Safety; and

(e) Before the first export shipment of the package, the shipper must submit a copy of the U.S. Competent Authority Certificate applying to that package design to the national competent authority of each country into or through which the package will be transported, unless a copy has already been furnished; and

(f) Import and export shipments may be made in accordance with § 171.12 of this subchapter.

(The information collection requirements contained in paragraphs (b) and (e) were approved by the Office of Management and Budget under control number 2137-0515)

§ 173.473 Requirements for foreign-made packages.

In addition to other applicable requirements of this subchapter, each shipper of a foreign-made Type B, Type B(U), Type B(M), or fissile material package for which a competent authority certificate is required by the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6," shall also comply with the following requirements:

(a) Prior to the first shipment of such a package of radioactive materials into or from the U.S., the shipper shall:

(1) Have the foreign competent authority certificate revalidated by the U.S. Competent Authority, unless this has been done previously. The request must be in duplicate and contain all the information required by Section VIII of the IAEA regulations. Each request is considered in the order in which it is received. To allow sufficient consideration by the Associate Administrator for Hazardous Materials Safety, requests should be received at least 45 days before the requested effective date.

(2) Submit a copy in English of the foreign competent authority certificate with the request for revalidation;

(3) Register its identity in writing with the U.S. Competent Authority as a user of the package covered by the foreign competent authority certificate and its revalidation. If the shipper is requesting the revalidation, this is automatically done by the Associate Administrator for Hazardous Materials Safety; and

(4) Supply to the carrier, upon request, the applicable competent authority certificates. However, the competent authority certificates are not required to accompany the packages to which they apply.

(b) The outside of each package shall be durably and legibly marked with the same competent authority identification marking indicated on the competent authority certificate and revalidation;

(c) Each shipping paper for a shipment of radioactive materials shall bear a notation of the package identification marking indicated on the competent authority certificate or revalidation;

(d) All requirements of the foreign competent authority certificate and the U.S. Competent Authority revalidation shall be fulfilled; and

(e) Import and export shipments may be made in accordance with § 171.12 of this subchapter.

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2137-0517)

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983; Amdt. 173-224, 55 FR 52670, Dec. 21, 1990; 56 FR 66279, Dec. 20, 1991]

§ 173.474 Quality control for construction of packaging.

(a) Prior to the first use of any packaging for the shipment of radioactive material, the shipper shall determine, that:

(1) The packaging meets the quality of design and construction requirements as specified in this subchapter; and

(2) The effectiveness of the shielding, containment, and, when required, the heat transfer characteristics of the package; are within the limits specified for the package design.

(b) [Reserved]

§ 173.475 Quality control requirements prior to each shipment of radioactive materials.

Before each shipment of any radioactive materials package, the shipper shall ensure by examination or appropriate tests, that:

(a) The packaging is proper for the contents to be shipped;

(b) The packaging is in unimpaired physical condition, except for superficial marks;

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

(d) For fissile material, each moderator and neutron absorber, if required, is present and in proper condition;

(e) Each special instruction for filling, closing, and preparation of the packaging for shipment has been followed;

(f) Each closure, valve, or other opening of the containment system through which the radioactive content might escape is properly closed and sealed;

(g) Each packaging containing liquid in excess of an A_2 quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than 0.25 atmosphere, absolute, (0.25 kilograms per square centimeter or 3.6 psia). The test must be conducted on the entire containment system, or on any receptacle or vessel within the containment system, to determine compliance with this requirement;

(h) The internal pressure of the containment system will not exceed the design pressure during transportation; and

(i) External radiation and contamination levels are within the allowable limits specified in this subchapter.

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983]

§ 173.476 Approval of special form radioactive materials.

(a) Each shipper of special form radioactive materials shall maintain on file for at least one year after the latest shipment, and provide to the RSPA on request, a complete safety analysis, including documentation of any tests, demonstrating that the special form material meets the requirements of § 173.469. An IAEA Certificate of Competent Authority issued for the special form material may be used to satisfy this requirement.

(b) Prior to the first export shipment of a special form radioactive ma-

terial from the United States, each shipper shall obtain a Competent Authority Certificate for the specific material. For special form material manufactured outside the United States an IAEA Certificate of Component Authority from the country of origin may be used to meet this requirement. For special form materials manufactured in the United States each shipper shall obtain a U.S. Competent Authority Certificate for the specific material. Each petition for a U.S. Competent Authority Certificate shall be submitted in accordance with § 173.471(e) and must include the following information:

(1) A detailed description of the material or if a capsule, a detailed description of the contents. Particular reference must be made to both physical and chemical states;

(2) If a capsule is to be used, a detailed statement of its design and dimensions, including complete engineering drawings and schedules of material, and methods of construction; and

(3) A statement of the tests that have been made and their results; evidence based on calculative methods to show that the material is able to pass the tests; or other evidence that the special form radioactive material complies with § 173.469.

(c) Paragraphs (a) and (b) of this section do not apply in those cases where A_1 equals A_2 and the material is not described on the shipping papers as "Radioactive Material, Special Form, n.o.s."

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2137-0516. The information collection requirements contained in paragraph (b) were approved under control number 2137-0518)

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31219, July 7, 1983]

§ 173.477 Approval for export shipments.

(a) Each export shipment of a package for which an IAEA certificate of competent authority has been issued or revalidated in accordance with §§ 173.471, 173.472, or 173.473 shall have multilateral approval, if the shipment includes:

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(3) A Fissile C

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(1) A vented Type B(M) package;

(2) A Type B(M) packaging containing radioactive materials with an activity greater than $3 \times 10^3 A_1$, or $3 \times 10^3 A_2$, as appropriate, or 3×10^4 curies, whichever is less;

(3) A Fissile Class III shipment; or

(4) Transportation by special arrangement.

(b) Each application for shipment approval shall contain:

(1) The period of time for which the approval is sought;

(2) A description of the contents, the expected modes of transportation, the type of conveyance to be used, and the proposed route; and

(3) An explanation of how the special precautions and special administrative and operational controls referred to in the package design certificates are to be put into effect.

(c) The packaging and shipment approvals may be combined into a single approval issued in accordance with §§ 173.471, 173.472 or 173.473.

(d) Approval by competent authorities is not required for packagings designed for materials covered by §§ 173.421 through 173.427 nor for Type A packagings designed for non-fissile radioactive materials.

(The information collection requirements contained in paragraph (b) were approved by the Office of Management and Budget under control number 2137-0532)

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31220, July 7, 1983]

§ 173.478 Notification to competent authorities for export shipments.

(a) Before the first export shipment of any packaging with contents exceeding A_1 or A_2 , the shipper shall ensure that copies of each applicable competent authority certificate issued in accordance with § 173.471, § 173.472, or § 173.473 have been submitted to the competent authority of each country through which or into which it is to be transported. The shipper is not required to await an acknowledgment from the competent authority prior to shipping the radioactive material, nor is the competent authority required to acknowledge receipt of the certificate.

(b) For each of the shipments described in this paragraph, the shipper shall notify the competent authority

of each country through which or into which the shipment is to be transported. This notification must be received by each competent authority at least 15 days before the shipment starts for the following:

(1) Type B(U) packagings containing radioactive materials with an activity greater than $3 \times 10^3 A_1$, $3 \times 10^3 A_2$, as appropriate, or 3×10^4 curies, whichever is the least;

(2) Type B(M) packages;

(3) Fissile Class III shipments under Section VIII of the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)"; or

(4) Transportation by special arrangements.

(c) The shipper notification must include:

(1) Sufficient information to enable the packaging to be identified, including all applicable certificate numbers and identification marks; and

(2) Information as to the date of shipment, the expected date of arrival, and the proposed routing.

(d) The shipper is not required to send a separate notification if the required information has been included in the application for shipment approval.

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2137-0515. The information collection requirements contained in paragraphs (b) and (c) were approved under control number 2137-0532)

[Amdt. 173-162, 48 FR 10226, Mar. 10, 1983, as amended at 48 FR 31220, July 7, 1983]

Subparts J-O—[Reserved]

APPENDIX A TO PART 173—METHOD OF TESTING CORROSION TO SKIN

1. Corrosion to the skin is measured by patch-test technique on the intact skin of the albino rabbit, clipped free of hair. A minimum of six subjects are to be used in this test.

2. Introduce under a square cloth patch, such as surgical gauze measuring not less than 1 inch by 1 inch and two single layers thick, 0.5 milliliter (in the case of liquids) or 0.5 gram (in the case of solids and semisolids) of the substance to be tested.

3. Immobilize the animals with patches secured in place by adhesive tape.

4. Wrap the entire trunk of each animal with an impervious material, such as rubberized cloth, for the 4 hour period of exposure. This material is to aid in maintaining the test patches in position and retards the evaporation of volatile substances. It is not applied for the purpose of occlusion.

5. After 4 hours of exposure, the patches are to be removed and the resulting reactions are to be evaluated for corrosion.

6. Following this initial reading, all test sites are washed with an appropriate solvent to prevent further exposure.

7. Readings are again to be made at least at the end of a total of 48 hours (44 hours after the first reading).

8. Corrosion will be considered to have resulted if the substances in contact with the rabbit skin have caused destruction or irreversible alteration of the tissue on at least two out of each six rabbits tested. Tissue destruction is considered to have occurred if, at any of the readings, there is ulceration or necrosis. Tissue destruction does not include merely sloughing of the epidermis, or erythema, edema, or fissuring.

[Amdt. 173-94, 41 FR 16092, Apr. 15, 1976, as amended by Amdt. 173-94A, 41 FR 40684, Sept. 20, 1976; Amdt. 173-94B, 41 FR 57070, Dec. 30, 1976; Amdt. 173-149, 46 FR 49906, Oct. 8, 1981]

APPENDIX B TO PART 173—PROCEDURE FOR TESTING CHEMICAL COMPATIBILITY AND RATE OF PERMEATION IN PLASTIC PACKAGING AND RECEPTACLES

1. The purpose of this procedure is to determine the chemical compatibility and permeability of liquid hazardous materials packaged in plastic packaging and receptacles. Alternatives for this procedure are permitted as specified in § 173.24(e)(3)(iii) of this subchapter.

2. Compatibility and rate of permeation are determined by subjecting full size plastic containers (or smaller containers as permitted in paragraph 4 of this Appendix) and hazardous material lading to one of the following combinations of time and temperature:

- Test Method 1: 180 days at a temperature no lower than 18°C. (64°F.)
- Test Method 2: 28 days at a temperature no lower than 50°C. (122°F.)
- Test Method 3: 14 days at a temperature no lower than 60°C. (140°F.)

3. Regardless of which test method is used, at least three sample containers shall be tested for each combination of hazardous material and size and design of container. Fill containers to rated capacity with the

specific hazardous material (at the concentration to be transported) and close as for shipment. For the first and last 24 hours of storage under the selected test method, place the containers with closures downward, except that containers fitted with a vent are so placed on each occasion for five minutes only.

4. For testing under Test Method 2 or 3 in those instances where it is not practicable to use full size containers, smaller containers may be used. The small container shall be manufactured by the same process as the larger container (for example, using the same method of molding and processing temperatures) and be made of identical resins, pigments and additives.

5. Determine filled container weight or net weight of contents both before and after storage under the selected test method. Rate of permeation is determined from loss of hazardous materials contents, during the conduct of the test, expressed as a percentage of the original weight.

6. After storage under the selected test method, the container shall be drained, rinsed, filled to rated capacity with water and, with filled container at ambient temperature, dropped from a height determined in accordance with § 178.603(d) of this subchapter onto a rigid non-resilient, flat and horizontal surface.

7. Each of the following constitute test failure:

- Visible evidence of permanent deformation due to vapor pressure build-up or collapse of walls, deterioration, swelling, crazing, cracking, excessive corrosion, oxidation, embrittlement, leakage, rupture or other defects likely to cause premature failure or a hazardous condition.
- For materials meeting the definition of a poison according to this subchapter, a rate of permeation in excess of 0.5% determined over the test period. For all other hazardous materials, a rate of permeation in excess of 2.0% determined over the test period.

(49 U.S.C. 1803, 1804, 1808; 49 CFR 1.53, App. A to Part 1)

[Amdt. 173-176, 49 FR 24691, June 14, 1984, as amended by Amdt. 173-224, 55 FR 52670 Dec. 21, 1990; 56 FR 66279, Dec. 20, 1991]

APPENDIX C TO PART 173—PROCEDURE FOR BASE-LEVEL VIBRATION TESTING

Base-level vibration testing shall be conducted as follows:

- Three sample packagings, selected at random, must be filled and closed as for shipment. A non-hazardous material may be used in place of the hazardous material if it has essentially the same physical characteristics.

2. The three packaging shall be placed on a vibrating platform (double-amplitude) of one inch (25.4 mm) constrained horizontally from falling off and left free to rotate.

3. The test must be conducted for one hour on each package to be tested on a vibrating platform to simulate the material of approximately 1/8 inch (3.175 mm) thickness (including paperboard) can be placed on the bottom of any packaging.

4. Immediately after the test, each packaging shall be examined from the platform to determine if any rupture or leakage is observed for any of the packages.

5. Rupture or leakage of any of the packages constitutes a test failure. [Amdt. 173-224, 55 FR 52670, Dec. 21, 1990]

APPENDIX D TO PART 173—PROCEDURE FOR TESTING OF PACKAGING FOR BLEASTING, THERMAL STABILITY, AND VIBRATION

I. Test method D-1

A wooden stick, 150 mm (6.0 in) long and 4.8 mm (0.2 in) in diameter, with a sharpened end is placed on one end of the wrapper. A cork stopper is placed in the bottom of a glass jar containing dynamite cartridge down, resting on the wrapper. The entire assembly is placed in an oven at 38 °C (100 °F) and examined visually for rupture or leakage.

2. Test method D-2

The test apparatus consists of a glass tube, 135 mm (5.3 in) in diameter, with both ends sealed in the following manner:

2. The three packages must be placed on a vibrating platform that has a vertical double-amplitude (peak-to-peak displacement) of one inch. The packages should be constrained horizontally to prevent them from falling off the platform, but must be left free to move vertically, bounce and rotate.

3. The test must be performed continuously for one hour at a frequency that causes each package to be raised from the vibrating platform to such a degree that a piece of material of approximately 1.6 mm (0.063 inch) thickness (such as steel strapping or paperboard) can be passed between the bottom of any package and the platform.

4. Immediately following the period of vibration, each package shall be removed from the platform, turned on its side and observed for any evidence of leakage.

5. Rupture or leakage from any of the packages constitutes failure of the test.

[Amtd. 173-224, 55 FR 52671, Dec. 21, 1990]

APPENDIX D TO PART 173—TEST METHODS FOR DYNAMITE (EXPLOSIVE, BLASTING, TYPE A)

1. Test method D-1—Leakage Test

A wooden stick, 114 mm (4.5 inches) long and 4.8 mm (0.2 inch) in diameter, with a sharpened end is used to punch 5 holes in one end of the wrapper of a dynamite cartridge. A cork stopper is placed on the bottom of a glass volumetric cylinder. The dynamite cartridge is placed, perforated end down, resting on the cork stopper in the cylinder. The entire assembly is placed in an oven at 38 °C (100 °F) for 48 hours and then examined visually for evidence of leakage.

2. Test method D-2—Centrifugal Exudation Test

The test apparatus consists of a glass tube, 135 mm (5.3 inches) long and one inch in diameter, with both ends open, and is assembled in the following manner:

(a) Close the bottom with a plastic plug of diameter equal to the inner diameter of the glass tube;

(b) Place a small amount of absorbent cotton on top of the plug;

(c) Place a plastic disk that matches the inner diameter to the glass tube and has seven small perforations on top of the cotton; and

(d) Place 10 g (0.35 ounce) of the dynamite sample on top of the disk.

The assembled glass tube is then placed in a hand-operated centrifuge and spun for one minute at 600 rpm (revolutions per minute). The dynamite sample is then removed from the glass tube and weighed to determine the percent of weight loss.

3. Test method D-3—Compression Exudation Test

The entire apparatus for this test is shown in Figure 1 of this appendix. The test is conducted using the following procedures:

(a) A glass tube, 135 mm (5.3 inches) long and one inch in diameter, is held on a wooden base;

(b) A small amount of absorbent cotton is placed into the bottom of the glass tube;

(c) Ten g (0.35 ounce) of dynamite sample are placed on top of the cotton in the glass tube;

(d) A small amount of absorbent cotton is placed on top of the dynamite sample;

(e) A plastic disk that matches the inner diameter of the glass tube and has seven small perforations is placed on top of the cotton;

(f) A plastic plug matching the inner diameter of the glass tube is then placed on top of the disk;

(g) The glass tube assembly is placed under the compression rod, and compression is applied by means of the weight on the metal lever rod. The sample is compressed for one minute; and

(h) The dynamite sample is then removed from the glass tube and weighed to determine the percent of weight loss.