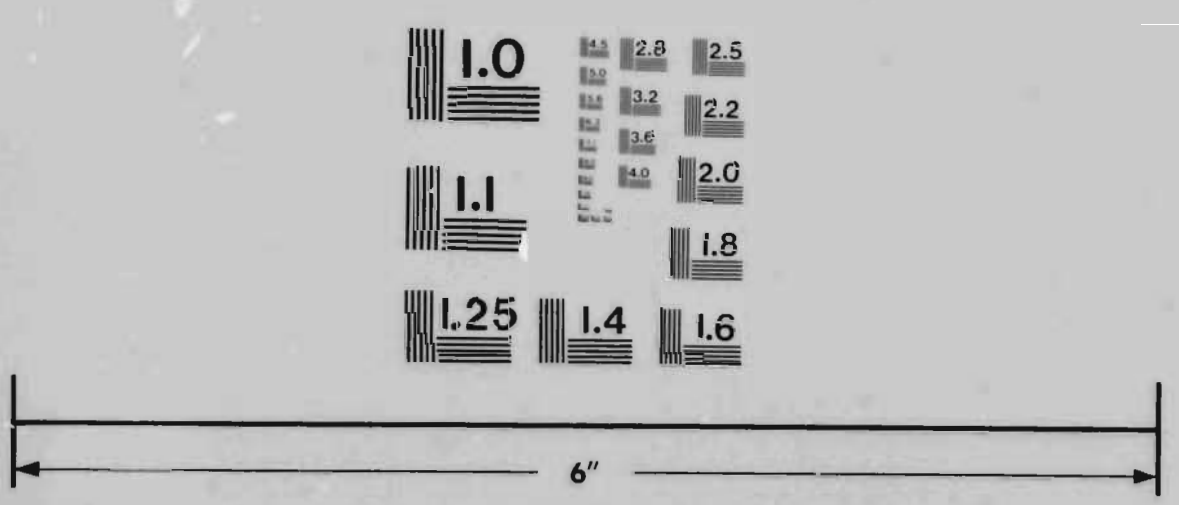
A 10 CFR, PART 71 - PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIAL. FICHE 784

RESOLUTION TEST
TARGET (NE-1)



conditions revealed by such application or statement of fact or any report, record, or inspection or other means which would warrant the Commission to refuse to grant a license on an original application, or for failure to construct or operate a facility in accordance with the terms of the construction permit or license, the technical specifications in the application, or for violation of, or failure to observe any of the terms and conditions of the Act, or of any regulation of the Commission.

(c) Upon revocation, suspension or modification of a license, the Commission may immediately retake possession of all special nuclear material held by the licensee. In cases found by the Commission to be of extreme importance to the national defense or security, or to the health and safety of the public, the Commission may recapture any special nuclear material held by the licensee prior to any of the procedures provided under section 551-558 of title 5 of the United States Code.

(d) Except in cases of willfulness or those in which the public health, interest or safety requires otherwise, no license shall be modified, suspended or revoked unless, prior to the institution of proceedings therefor, facts or conduct which may warrant such action shall have been called to the attention of the licensee in writing and the licensee shall have been accorded opportunity to demonstrate or achieve compliance with all lawful requirements.

[21 FR 764, Feb. 3, 1956, as amended at 35 FR 11461, July 17, 1970]

**§ 70.62 Suspension and operation in war or national emergency.**

Whenever Congress declares that a state of war or national emergency exists, the Commission, if it finds it necessary to the common defense and security may,

(a) Suspend any license it has issued.

(b) Order the recapture of special nuclear material.

(c) Order the operation of any licensed facility.

(d) Order entry into any plant or facility in order to recapture special nuclear material or to operate the facility. Just compensation shall be paid for any damages caused by recapture of special nuclear material or by operation of any facility, pursuant to this section.

[21 FR 764, Feb. 3, 1956, as amended at 32 FR 4056, Mar. 15, 1967; 35 FR 11461, July 17, 1970]

### Enforcement

**§ 70.71 Violations.**

An injunction or other court order may be obtained prohibiting any violation of any provision of the Atomic Energy Act of 1954, as amended, or Title II of the Energy Reorganization Act of 1974, or any regulation or order issued thereunder. A court order may be obtained for the payment of a civil penalty imposed pursuant to section 234 of the Act for violation of section 53, 57, 62, 63, 81, 82, 101, 103, 104, 107, or 109 of the Act, or section 206 of the Energy Reorganization Act of 1974, or any rule, regulation, or order issued thereunder, or any term, condition, or limitation of any license issued thereunder, or for any violation for which a license may be revoked under section 186 of the Act. Any person who willfully violates any provision of the Act or any regulation or order issued thereunder may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

[40 FR 8792, Mar. 3, 1975]

## PART 71—PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIAL

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AUTHORITY: Secs. 53, 57, 62, 63, 81, 161, 182, 183, 68 Stat. 930, 932, 933, 935, 948, 953, 954, as amended (42 U.S.C. 2073, 2077, 2092, 2093, 2111, 2201, 2232, 2233); Secs. 201, as amended, 202, 206, 68 Stat. 1242, as amended, 1244, 1246 (42 U.S.C. 5841, 5842, 5846).

Section 71.97 also issued under sec. 301, Pub. L. 96-295, 94 Stat. 789-790.

For the purposes of sec. 223, 68 Stat. 958, as amended (42 U.S.C. 2273), §§ 71.3, 71.43, 71.45, 71.55, 71.83 (a) and (b), 71.83, 71.85, 71.87, 71.99, and 71.97 are issued under sec. 161b, 68 Stat. 948, as amended (42 U.S.C. 2201(b)), and §§ 71.5(b), 71.91, 71.93, 71.95 and 71.101(a) are issued under sec. 161o, 68 Stat. 950, as amended (42 U.S.C. 2201(o)).

SOURCE: 48 FR 35607, Aug. 5, 1983, unless otherwise noted.

## Subpart A—General Provisions

### § 71.0 Purpose and scope

(a) This part establishes (1) requirements for packaging, preparation for shipment, and transportation of licensed material, and (2) procedures and standards for NRC approval of packaging and shipping procedures for fissile material and for a quantity of other licensed material in excess of a Type A quantity.

(b) The packaging and transport of licensed material are also subject to other parts of this chapter (e.g., Parts 20, 21, 30, 40, 70, and 73) and to the regulations of other agencies (e.g., the U.S. Department of Transportation (DOT) and the U.S. Postal Service (USPS)[1]) having jurisdiction over means of transport. The requirements of this part are in addition to, and not in substitution for, other requirements.

(c) The regulations in this part apply to any licensee authorized by specific license issued by the Commission to receive, possess, use, or transfer licensed material if the licensee delivers that material to a carrier for transport or transports the material outside the confines of the licensee's facility, plant, or other authorized place of use. No provision of this part authorizes possession of licensed material.

(d) Exemptions from the requirement for license in § 71.3 are specified in § 71.10. General licenses for which no NRC package approval is required are issued in §§ 71.14 through 71.24. The general license in § 71.12 requires that an NRC certificate of compliance or other package approval be issued for the package to be used under the general license. Application for package approval must be completed in accordance with Subpart D of this part, demonstrating that the design of the package to be used satisfies the package approval standards contained in Subpart E of this part as related to the tests of Subpart F of this part. The transport of licensed material or delivery of licensed material to a carrier for transport is subject to the operating controls and procedures requirements of Subpart G of this part, to the quality assurance requirements of Subpart H of this part, and to the general provisions of Subpart A of this part, including DOT regulations referenced in § 71.5.

[48 FR 35607, Aug. 5, 1983; 48 FR 38449, Aug. 24, 1983]

### § 71.1 Communications.

All communications concerning the regulations in this part should be addressed to the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, or may be delivered in person at the Commission offices at 1717 H Street, NW., Washington, DC, or its offices at 7915 Eastern Avenue, Silver Spring, Maryland.

### § 71.2 Interpretations.

Only written interpretations of the regulations in this part by the Commission's General Counsel are binding upon the Commission.

### § 71.3 Requirement for license.

A licensee subject to the regulations in this part may not (a) deliver any licensed material to a carrier for transport or (b) transport licensed material except as authorized in a general license or a specific license issued by the Commission, or as exempted in this part.

### § 71.4 Definitions.

The following terms are as defined here for the purpose of this part. Throughout this part the standards are expressed in metric units, the approximate English equivalents presented in parentheses are for information only.

$A_1$ means the maximum activity of special form radioactive material permitted in a Type A package. $A_2$ means the maximum activity of radioactive material, other than special form radioactive material, permitted in a Type A package. These values are either listed in Appendix A of this part, Table A-1, or may be derived in

[1] Postal Service Manual (Domestic Mail Manual), section 124.3, which is incorporated by reference at 39 CFR 111.1 (1974).

accordance with the procedure prescribed in Appendix A of this part.

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

*Close reflection by water* means immediate contact by water of sufficient thickness for maximum reflection of neutrons.

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

*Conveyance* means any vehicle, aircraft, vessel, freight container, or hold compartment, or defined deck area of an inland waterway craft or seagoing vessel.

*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.

*Fissile classification* means the categorization of fissile material packages into one of the following three classes according to the controls needed to provide nuclear criticality safety during transportation.

(1) Fissile Class I. A package which may be transported in unlimited numbers and in any arrangement, and which requires no nuclear criticality safety controls during transportation. A transport index is not assigned for purposes of nuclear criticality safety but may be required because of external radiation levels.

(2) Fissile Class II. A package which may be transported together with other packages in any arrangement but, for criticality control, in numbers which do not exceed an aggregate transport index of 50. These shipments require no other nuclear criticality safety control during transportation. Individual packages may have a transport index not less than 0.1 and not more than 10.

(3) Fissile Class III. A shipment of packages which is controlled in transportation by specific arrangements between the shipper and the carrier to provide nuclear criticality safety.

*Fissile material* and *fissile radionuclides*. "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 is fissile material. Fissile materials are classified in this section according to the controls needed to provide nuclear criticality safety during transportation. Certain exclusions are provided in § 71.53.

*Low specific activity material* 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 per gram of contents does not exceed:

(i) 0.0001 millicurie of radionuclides for which the $A_2$ quantity in Appendix A of this part is not more than 0.05 curie;

(ii) 0.05 millicurie of radionuclides for which the $A_2$ quantity in Appendix A of this part is more than 0.05 curie, but not more than 1 curie, or

(iii) 0.3 millicurie of radionuclides for which the $A_2$ quantity in Appendix A of this part 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 in Appendix A of Part 71 is not more than 0.05 curie, or 0.001 millicurie (2,200,000 disintegrations per minute) per square centimeter for other radionuclides.

*Maximum normal operating pressure* means the maximum gauge pres-

sure that would develop in the containment system in a period of one year under the heat test specified in § 71.7 (c)(1), in the absence of venting, external cooling by an ancillary system, or operational controls during transport.

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

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

*Optimum interspersed hydrogenous moderation* means the presence of hydrogenous material between packages to such an extent that the maximum nuclear reactivity results.

*Package* means the packaging together with its radioactive contents as presented for transport.

(1) *Fissile material package* means a fissile material packaging together with its fissile contents.

(2) *Type B package* means a Type B package together with its radioactive contents. On approval, a Type B package design is designated by NRC as B(U) unless the package has a maximum normal operating pressure of more than 700 kilopascal (100 lb/in²) gauge or a pressure relief device which would allow the release of radioactive material to the environment under the tests specified in § 71.73 (hypothetical accident conditions), in which case it will receive a designation B(M). B(U) refers to the need for unilateral approval of international shipments. B(M) refers to the need for multilateral approval. There is no distinction made in how packages with these designations may be used in domestic transportation. To determine their distinction for international transportation, see DOT regulations in 49 CFR Part 173. A Type B package approved prior to September 6, 1983, was designated only as Type B. Limitations on its use are specified in § 71.13.

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

*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 § 71.75.

A special form encapsulation designed in accordance with the requirements of § 71.4(o) of this part in effect on June 30, 1983, and constructed prior to July 1, 1985 may continue to be used. A special form encapsulation either designed or constructed after June 30, 1985 must meet requirements of this paragraph applicable at the time of its design or construction.

*Specific activity* of a radionuclide means the radioactivity 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 radioactivity per unit mass of the material.

*State* means the several States of the Union, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, the trust Territory of the Pacific Islands, and the Commonwealth of the Northern Mariana Islands.

*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 1 meter from the external surface of the package, or

(2) For Fissile Class II packages, the number expressing the maximum radiation level in millirem per hour at 1 meter from the external surface of the package, or the number obtained by dividing 50 by the allowable number of the packages which may be transport-

ed together as determined under § 71.59, whichever number is larger.

*Type A quantity* means a quantity of radioactive material, the aggregate radioactivity of which does not exceed $A_1$ for special form radioactive material or $A_2$ for normal form radioactive material, where $A_1$ and $A_2$ are given in Appendix A of this part or may be determined by procedures described in Appendix A of this part.

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

*Uranium—natural depleted enriched*

(1) *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).

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

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

[48 FR 35607, Aug. 5, 1983; 48 FR 38449, Aug. 24, 1983]

**§ 71.5 Transportation of licensed material.**

(a) Each licensee who transports licensed material outside of the confines of its plant or other place of use, or who delivers licensed material to a carrier for transport, shall comply with the applicable requirements of the regulations appropriate to the mode of transport of DOT in 49 CFR Parts 170 through 189.

(1) The licensee shall particularly note DOT regulations in the following areas:

(i) Packaging—49 CFR Part 173, Subparts A and B and §§ 173.401 through 173.478.

(ii) Marking and labeling—49 CFR Part 172, Subpart D and §§ 172.400 through 172.407, 172.436 through 172.440.

(iii) Placarding—49 CFR Part 172.500 through 172.519, 172.556 and Appendices B and C.

(iv) Monitoring—49 CFR Part 172, Subpart C.

(v) Accident reporting—49 CFR Part 171.15 and 171.16.

(vi) Shipping papers—49 CFR Part 172, Subpart C.

(2) The licensee shall also note DOT regulations pertaining to the following modes of transportation:

(i) Rail—49 CFR Part 174, Subparts A-D and K.

(ii) Air—49 CFR Part 176, Subparts A-D and M.

(iii) Vessel—49 CFR Part 176, Subparts A-D and M.

(iv) Public Highway—49 CFR Part 177.

(b) If DOT regulations are not applicable to a shipment of licensed material by rail, highway, or water because the shipment or the transportation of the shipment is not in interstate or foreign commerce, or to a shipment of licensed material by air because the shipment is not transported in civil aircraft, the licensee shall conform to the standards and requirements of the DOT specified in paragraph (a) of this section to the same extent as if the shipment or transportation were in interstate or foreign commerce or in civil aircraft. A request for modification, waiver, or exemption from those requirements, and any notification referred to in those requirements, must be filed with or made to the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

**§ 71.6 Information collection requirements: OMB approval.**

(a) The Nuclear Regulatory Commission has submitted the information collection requirements contained in this part to the Office of Management and Budget (OMB) for approval as required by the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 et seq.). OMB has approved the information collection requirements contained in this part under control number 3150-0008.

(b) The approved information collection requirements contained in this part appear in §§ 71.5, 71.12, 71.31, 71.33, 71.35, 71.37, 71.85, 71.87, 71.89, 71.91, 71.93, 71.95, 71.97, 71.101, 71.103, 71.105, 71.107, 71.109, 71.111, 71.113, 71.115, 71.117, 71.119, 71.121, 71.123, 71.125, 71.127, 71.129, 71.131, 71.133, 71.135, and 71.137.

[49 FR 19628, May 9, 1984]

## Subpart B—Exemptions

### § 71.7 Specific exemptions.

On application of any interested person or on its own initiative, the Commission may grant any exemption from the requirements of the regulations in this part that it determines is authorized by law and will not endanger life or property or the common defense and security.

### § 71.9 Exemption of physicians.

Any physician licensed by a State of the United States to dispense drugs in the practice of medicine is exempt from § 71.5 with respect to transport by the physician of licensed material for use in the practice of medicine. However, any physician operating under this exemption must be licensed under 10 CFR Part 35.

### § 71.10 Exemption for low level materials.

(a) A licensee is exempt from all requirements of this part with respect to shipment or carriage of a package containing radioactive material having a specific activity not greater than 0.002 microcurie/gram.

(b) A licensee is exempt from all requirements of this part, other than § 71.5 and § 71.88, with respect to shipment or carriage of the following packages:

(1) A package containing no more than a Type A quantity of radioactive material if the package contains no fissile material or if the fissile material exemption standards of § 71.53 are satisfied, or

(2) A package transported between locations within the United States which contains only americium or plutonium in special form with an aggregate radioactivity not to exceed 20 curies, if the package contains no fissile material or if the fissile material exemption standards of § 71.53 are satisfied.

## Subpart C—General Licenses

### § 71.12 General license: NRC approved package.

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

(b) This general license applies only to a licensee who has a quality assurance program approved by the Commission as satisfying the provisions of Subpart H of this part.

(c) This general license applies only to a licensee who:

(1) Has a copy of the specific license, certificate of compliance, or other approval of the package and has the drawings and other documents referenced in the approval relating to the use and maintenance of the packaging and to the actions to be taken prior to shipment;

(2) Complies with the terms and conditions of the license, certificate, or other approval, as applicable, and the applicable requirements of Subparts A, G, and H of this part, and

(3) Submits in writing to the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, prior to the licensee's first use of the package, the licensee's name and license number and the package identification number specified in the package approval.

(d) This general license applies only when the package approval authorizes use of the package under this general license.

(e) For previously approved Type B packages which are not designated as either B(U) or B(M) in the NRC Certificate of Compliance, this general license is subject to the additional restrictions of § 71.13.

[48 FR 35607, Aug. 5, 1983; 48 FR 38449, Aug. 24, 1983]

### § 71.13 Previously approved Type B package.

(a) A Type B package previously approved by the NRC, but not designated as B(U) or B(M) in the NRC Certif-



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icate of Compliance, may be used under the general license of § 71.12 with the following additional limitations:

(1) Fabrication of the packaging was satisfactorily completed before August 31, 1986, as demonstrated by application of its model number in accordance with § 71.85(c), and

(2) The package may not be used for a shipment to a location outside the United States after August 31, 1986, except under special arrangement approved by DOT in accordance with 49 CFR 173.471.

(b) The NRC will approve modifications to the design and authorized contents of a Type B package previously approved by the NRC, but not designated as B(U) or B(M) in the NRC Certificate of Compliance, provided:

(1) The modifications are not significant with respect to the design, operating characteristics, or safe performance of the containment system when the package is subjected to the tests specified in §§ 71.71 and 71.73, and

(2) The modification to the package satisfies the requirements of this part.

(c) The NRC will revise the package identification number to designate previously approved Type B package designs as B(U) or B(M) after receipt of an application demonstrating that the design meets the requirements of this part.

### § 71.14 General license: DOT specification container.

(a) A general license is issued to any licensee of the Commission to transport or to deliver to a carrier for transport licensed material in a specification container for fissile material or for a Type B quantity of radioactive material as specified in the regulations of DOT in 49 CFR Parts 173 and 178.

(b) This general license applies only to a licensee who has a quality assurance program approved by the Commission as satisfying the provisions of Subpart H of this part.

(c) This general license applies only to a licensee who:

(1) Has a copy of the specification; and

(2) Complies with the terms and conditions of the specification and the applicable requirements of Subparts A, G, and H of this part.

(d) This general license is subject to the limitation that the specification container may not be used for a shipment to a location outside the United States after August 31, 1986, except under special arrangements approved by DOT in accordance with 49 CFR 173.472.

### § 71.16 General License: Use of foreign approved package.

(a) A general license is issued to any licensee of the Commission to transport or to deliver to a carrier for transport licensed material in a package the design of which has been approved in a foreign national competent authority certificate which has been revalidated by DOT as meeting the applicable requirements of 49 CFR 171.12.

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

(c) This general license applies only to a licensee who:

(1) Has a copy of the applicable certificate, the revalidation, and the drawings and other documents referenced in the certificate relating to the use and maintenance of the packaging and to the actions to be taken prior to shipment; and

(2) Complies with the terms and conditions of the certificate and revalidation and with the applicable requirements of Subparts A, G, and H of this part. With respect to the quality assurance provisions of Subpart H of this part, the licensee is exempt from design, construction, and fabrication considerations.

[48 FR 35607, Aug. 5, 1983; 48 FR 38449, Aug. 24, 1983]

### § 71.18 General license: Type A, Fissile Class II package.

(a) A general license is issued to any licensee of the Commission to transport fissile material, or to deliver fissile material to a carrier for transport, without complying with the package standards of Subparts E and F of this part if the material is shipped as a Fissile Class II package.

(b) This general license applies only when a package contains no more than

a Type A quantity of radioactive material, including only one of the following:

(1) Up to 40 grams of uranium-235, or

(2) Up to 30 grams of uranium-233, or

(3) Up to 25 grams of the fissile radionuclides of plutonium, except that for encapsulated plutonium-beryllium neutron sources in special form, an A₂ quantity of plutonium may be present, or

(4) A combination of fissile radionuclides in which the sum of the ratios of the amount of each radionuclide to the corresponding maximum amounts in paragraphs (b)(1), (2), and (3) of this section does not exceed unity.

(c) This general license applies only when, except as specified below for encapsulated plutonium-beryllium sources, a package containing more than 15 grams of fissile radionuclides is labeled with a transport index not less than the number given by the following equation, where the package contains x grams of uranium-235, y grams of uranium-233 and z grams of the fissile radionuclides of plutonium:

$$\text{Minimum Transport Index} = \left(0.40x + 0.67y + z\right)\left(1 - \frac{15}{x + y + z}\right)$$

For a package in which the only fissile material is in the form of encapsulated plutonium-beryllium neutron sources in special form, the transport index based on criticality considerations may be taken as 0.026 times the number of grams of the fissile radionuclides of plutonium in excess of 15 grams. In all cases, the transport index must be rounded up to one decimal place, and may not exceed 10.0.

[48 FR 35607, Aug. 5, 1983; 48 FR 38449, Aug. 24, 1983; 48 FR 51903, Nov. 15, 1983]

### § 71.20 General license: Restricted, Fissile Class II package.

(a) A general license is issued to any licensee of the Commission to transport fissile material, or to deliver fissile material to a carrier for transport, without complying with the package standards of Subparts E and F of this part if the material is shipped as a Fissile Class II package.

(b) This general license applies only when:

(1) The package contains no more than a Type A quantity of radioactive material; and

(2) Neither beryllium nor hydrogenous material enriched in deuterium is present; and

(3) The total mass of graphite present does not exceed 150 times the total mass of uranium-235 plus plutonium; and

(4) Substances having a higher hydrogen density than water, e.g., certain hydrocarbon oils, are not present, except that polyethylene may be used for packing or wrapping, and

(5) Uranium-233 is not present, and the amount of plutonium does not exceed 1% of the amount of uranium-235, and

(6) The amount of uranium-235 is limited as follows:

(i) If the fissile radionuclides are not uniformly distributed, the maximum amount of uranium-235 per package may not exceed the value given in Table I of this part, or

TABLE I—PERMISSIBLE MASS OF URANIUM-235 PER FISSILE CLASS II PACKAGE APPLICABLE TO § 71.20(b)(6)(i)

[Non-uniform distribution]

| Uranium enrichment in weight percent of uranium-235 not exceeding | Permissible maximum grams of uranium-235 per package |
|---|---|
| 24 | 40 |
| 20 | 42 |
| 15 | 45 |
| 11 | 48 |
| 10 | 51 |
| 8.5 | 52 |
| 8 | 54 |
| 6.5 | 55 |
| 6 | 57 |
| 7.5 | 59 |
| 7 | 60 |
| 6.5 | 62 |
| 6 | 65 |
| 5.5 | 68 |
| 5 | 72 |
| 4.5 | 76 |
| 4 | 80 |
| 3.5 | 88 |

TABLE I—PERMISSIBLE MASS OF URANIUM-235 PER FISSILE CLASS II PACKAGE APPLICABLE TO § 71.20(b)(6)(i)—Continued

[Non-uniform distribution]

| Uranium enrichment in weight percent of uranium-235 not exceeding | Permissible maximum grams of uranium-235 per package |
|---|---|
| 3 | 100 |
| 2.5 | 120 |
| 2 | 184 |
| 1.5 | 272 |
| 1.35 | 320 |
| 1 | 680 |
| 0.82 | 1,200 |

(ii) If the fissile radionuclides are distributed uniformly (i.e., cannot form a lattice arrangement within the packaging) the maximum amount of uranium-235 per package may not exceed the value given in Table II of this part; and

TABLE II—PERMISSIBLE MASS OF URANIUM-235 PER FISSILE CLASS II PACKAGE APPLICABLE TO § 71.20(b)(6)(ii)

[Uniform distribution]

| Uranium enrichment in weight percent of uranium-235 not exceeding | Permissible maximum grams of uranium-235 per package |
|---|---|
| 4 | 84 |
| 3.5 | 92 |
| 3 | 112 |
| 2.5 | 148 |
| 2 | 240 |
| 1.5 | 560 |
| 1.36 | 800 |

(7) The transport index of each package based on criticality considerations is taken as 10 times the number of grams of uranium-235 in the package divided by the maximum allowable number of grams per package in accordance with Table I or Table II of this part as applicable.

[48 FR 35607, Aug. 5, 1983; 48 FR 38449, Aug. 24, 1983]

**§ 71.22 General license: Type A package, Fissile Class III shipment.**

(a) A general license is issued to any licensee of the Commission to transport fissile material, or to deliver fissile material to a carrier for transport, without complying with the package standards of Subparts E and F of this part if limited material is shipped as a Fissile Class III shipment.

(b) This general license applies only when a package contains no more than a Type A quantity of radioactive material and no more than 400 grams total of the fissile radionuclides of plutonium encapsulated as plutonium-beryllium neutron sources in special form.

(c) This general license applies only when the fissile radionuclides in the Fissile Class III shipment exceeds none of the following:

(1) 500 grams of uranium-235, or

(2) 300 grams total of uranium-233, and the fissile radionuclides of plutonium; or

(3) A total quantity of uranium-233, uranium-235, and the fissile radionuclides of plutonium such that the sum of the ratios of the quantity of each radionuclide to the quantity specified in paragraphs (c)(1) and (c)(2) of this section exceeds unity; or

(4) 2500 grams total of the fissile radionuclides of plutonium encapsulated as plutonium-beryllium neutron sources in special form.

(d) This general license applies only when shipment of these packages is made under procedures specifically authorized by DOT in accordance with 49 CFR Part 173 of its regulations to prevent loading, transport or storage of these packages with other Fissile Class II packages or Fissile Class III shipments.

**§ 71.24 General license: Restricted, Fissile Class III shipment.**

(a) A general license is issued to any licensee of the Commission to transport fissile material, or to deliver fissile material to a carrier for transport, without complying with the package standards of Subparts E and F of this part if limited material is shipped as a Fissile Class III shipment.

(b) This general license applies only when:

(1) No package contains more than a Type A quantity of radioactive material; and

(2) The packaging does not incorporate lead shielding exceeding 5 cm in thickness, tungsten shielding, or uranium shielding; and

(3) Neither beryllium nor hydrogenous material enriched in deuterium is present, and

(4) The total mass of graphite present does not exceed 150 times the total mass of uranium-235 and plutonium, and

(5) Substances having a higher hydrogen density than water, e.g., certain hydrocarbon oils, are not present, except that polyethylene may be used for packing or wrapping, and

(6) For fissile contents containing no uranium-233 and less than 1% total plutonium:

(i) If the fissile radionuclides are not uniformly distributed, the maximum amount of uranium-235 per consignment does not exceed the value given in Table III of this part, or

TABLE III—PERMISSIBLE MASS OF URANIUM-235 PER FISSILE CLASS III SHIPMENT APPLICABLE TO § 71.24(b)(6)(i)

[Nonuniform distribution]

| Uranium enrichment in weight percent of uranium 235 not exceeding | Permissible maximum grams of uranium 235 per consignment |
|---|---|
| 20 | 520 |
| 15 | 560 |
| 11 | 600 |
| 10 | 640 |
| 9.5 | 655 |
| 9 | 675 |
| 8.5 | 690 |
| 8 | 710 |
| 7.5 | 730 |
| 7 | 750 |
| 6.5 | 780 |
| 6 | 810 |
| 5.5 | 850 |
| 5 | 900 |
| 4.5 | 950 |
| 4 | 1,000 |
| 3.5 | 1,100 |
| 3 | 1,250 |
| 2.5 | 1,500 |
| 2 | 2,050 |
| 1.5 | 3,400 |

TABLE III—PERMISSIBLE MASS OF URANIUM-235 PER FISSILE CLASS III SHIPMENT APPLICABLE TO § 71.24(b)(6)(i)—Continued

[Nonuniform distribution]

| Uranium enrichment in weight percent of uranium 235 not exceeding | Permissible maximum grams of uranium 235 per consignment |
|---|---|
| 1.35 | 4,000 |
| 1 | 8,500 |
| 0.92 | 15,000 |

(ii) If the fissile radionuclides are distributed uniformly and cannot form a lattice arrangement within the packaging, the maximum amount of uranium-235 per shipment does not exceed the value given in Table IV of this part, and

TABLE IV—PERMISSIBLE MASS OF URANIUM-235 PER FISSILE CLASS III SHIPMENT APPLICABLE TO § 71.24(b)(6)(ii)

[Uniform distribution]

| Uranium enrichment in weight percent of uranium 235 not exceeding | Permissible maximum grams of uranium 235 per consignment |
|---|---|
| 4 | 1,050 |
| 3.5 | 1,150 |
| 3 | 1,400 |
| 2.5 | 1,800 |
| 2 | 3,900 |
| 1.5 | 7,000 |
| 1.35 | 10,000 |

(7) For fissile contents containing uranium-233 or more than 1% plutonium, the total mass of fissile material per shipment is limited so that the sum of the number of grams of uranium-235 divided by 400, the number of grams of plutonium divided by 225, and the number of grams of uranium-233 divided by 250 does not exceed unity as expressed in the formula

$$\frac{\text{grams uranium 235}}{400\text{ grams}} + \frac{\text{grams plutonium}}{225\text{ grams}} + \frac{\text{grams uranium 233}}{250\text{ grams}} \leq 1, \quad \text{and}$$

(8) The transport must be direct to the consignee without any intermediate transit storage, and

(9) Shipment of these packages is made under procedures specifically authorized by DOT in accordance with 49 CFR Part 173 of its regulations to prevent loading, transport or storage of these packages with other Fissile Class II packages or Fissile Class III shipments.

[48 FR 35607, Aug. 5, 1983; 48 FR 38449, Aug. 24, 1983]

## Subpart D—Application for Package Approval

### § 71.31 Contents of application.

(a) An application for an approval under this part must include, for each proposed packaging design, the following information:

(1) A package description as required by § 71.33.

(2) A package evaluation as required by § 71.35.

(3) A quality assurance program description as required by § 71.37;

(4) In the case of fissile material, an identification of the proposed fissile class.

(b) Except as provided in § 71.13, an application for modification of a package design, whether for modification of the packaging or authorized contents, must include sufficient information to demonstrate that the proposed design satisfies the package standards in effect at the time the application is filed.

[48 FR 35607, Aug. 5, 1983; 48 FR 38449, Aug. 24, 1983]

### § 71.33 Package description.

The application must include a description of the proposed package in sufficient detail to identify the package accurately and provide a sufficient basis for evaluation of the package. The description must include:

(a) With respect to the packaging:

(1) Classification as Type B(U), Type B(M), or fissile material packaging.

(2) Gross weight;

(3) Model number;

(4) Identification of the containment system;

(5) Specific materials of construction, weights, dimensions, and fabrication methods of:

(i) Receptacles;

(ii) Materials specifically used as nonfissile neutron absorbers or moderators;

(iii) Internal and external structures supporting or protecting receptacles;

(iv) Valves, sampling ports, lifting devices, and tie-down devices;

(v) Structural and mechanical means for the transfer and dissipation of heat, and

(6) Identification and volumes of any receptacles containing coolant.

(b) With respect to the contents of the package:

(1) Identification and maximum radioactivity of radioactive constituents;

(2) Identification and maximum quantities of fissile constituents;

(3) Chemical and physical form;

(4) Extent of reflection, the amount and identity of nonfissile materials used as neutron absorbers or moderators, and the atomic ratio of moderator to fissile constituents;

(5) Maximum normal operating pressure;

(6) Maximum weight;

(7) Maximum amount of decay heat, and

(8) Identification and volumes of any coolants.

[48 FR 35607, Aug. 5, 1983; 48 FR 38449, Aug. 24, 1983]

### § 71.35 Package evaluation.

The application must include:

(a) A demonstration that the package satisfies the standards specified in Subparts E and F of this part;

(b) For a Fissile Class II package, the allowable number of packages which may be transported in the same vehicle in accordance with § 71.59, and

(c) For a Fissile Class III shipment, any proposed special controls and precautions for transport, loading, unloading, and handling, and any proposed special controls in the event of accident or delay.

### § 71.37 Quality assurance.

(a) The applicant shall describe the quality assurance program (see Subpart H of this part) for the design, fabrication, assembly, testing, maintenance, repair, modification, and use of the proposed package.

(b) The applicant shall identify any established codes and standards proposed for use in package design, fabrication, assembly, testing, maintenance, and use. In the absence of any codes and standards, the applicant shall describe the basis and rationale used to

formulate the package quality assurance program.

(c) The applicant shall identify any specific provisions of the quality assurance program which are applicable to the particular package design under consideration, including a description of the leak testing procedures.

### § 71.39 Requirement for additional information

The Commission may at any time require additional information in order to enable it to determine whether a license, certificate of compliance, or other approval should be granted, denied, modified, suspended, or revoked.

## Subpart E—Package Approval Standards

### § 71.41 Demonstration of compliance.

(a) The effects on a package of the tests specified in § 71.71 (Normal Conditions of Transport) and the tests specified in § 71.73 (Hypothetical Accident Conditions) must be evaluated by subjecting a sample package or scale model to test, or by other method of demonstration acceptable to the Commission, as appropriate for the particular feature being considered.

(b) Taking into account the type of vehicle, the method of securing or attaching the package, and the controls to be exercised by the shipper, the Commission may permit the shipment to be evaluated together with the transporting vehicle.

(c) Environmental and test conditions different from those specified in §§ 71.71 and 71.73 may be approved by the Commission if the controls proposed to be exercised by the shipper are demonstrated to be adequate to assure the safety of the shipment.

### § 71.43 General standards for all packages.

(a) The smallest overall dimension of a package must not be less than 10 cm (four in.).

(b) The outside of a package must incorporate a feature, such as a seal, which is not readily breakable, and which, while intact, would be evidence that the package has not been opened by unauthorized persons.

(c) Each package must include a containment system securely closed by a positive fastening device which cannot be opened unintentionally.

(d) A package must be of materials and construction which assure that there will be no significant chemical, galvanic, or other reaction among the packaging components or between the packaging components and the package contents, including possible reaction resulting from inleakage of water to the maximum credible extent.

(e) A package valve or other device, the failure of which would allow radioactive contents to escape, must be protected against unauthorized operation and, except for a pressure relief device, must be provided with an enclosure to retain any leakage.

(f) A package must be designed, constructed and prepared for shipment so that under the tests specified in § 71.71 (Normal Conditions of Transport) there would be no loss or dispersal of radioactive contents, no significant increase in external radiation levels, and no substantial reduction in the effectiveness of the packaging.

(g) A package must be designed, constructed, and prepared for transport so that in still air at 38°C (100°F) and in the shade, no accessible surface of a package would have a temperature exceeding 50°C (122°F) in a non-exclusive use shipment or 82°C (180°F) in an exclusive use shipment.

(h) A package must not incorporate a feature which is intended to allow continuous venting during transport.

### § 71.45 Lifting and tie-down standards for all packages.

(a) Any lifting attachment that is a structural part of a package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and must be designed so that failure of any lifting device under excessive load would not impair the ability of the package to meet other requirements of this subpart. Any other structural part of the package which could be used to lift the package must be capable of being rendered

inoperable for lifting the package during transport or must be designed with strength equivalent to that required for lifting attachments.

(b) Tie-down devices:

(1) If there is a system of tie-down devices which is a structrual part of the package, the system must be capable of withstanding, without generating stress in any material of the package in excess of its yield strength, a static force applied to the center of gravity of the package having a vertical component of two times the weight of the package with its contents, a horizontal component along the direction in which the vehicle travels of 10 times the weight of the package with its contents, and a horizontal component in the transverse direction of five times the weight of the package with its contents.

(2) Any other structural part of the package which could be used to tie down the package must be capable of being rendered inoperable for tying down the package during transport, or must be designed with strength equivalent to that required for tie-down devices.

(3) Each tie-down device which is a structural part of a package must be designed so that failure of the device under excessive load would not impair the ability of the package to meet other requirements of this part.

[48 FR 35607, Aug. 5, 1983; 48 FR 38449, Aug. 24, 1983]

### § 71.47 External radiation standards for all packages.

A package must be designed and prepared for shipment so that 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 (See § 71.4 "Definitions"). For a package transported as exclusive use by rail, highway, or water, radiation levels external to the package may exceed those limits, but must not exceed any of the following:

(a) 200 millirem/hour on the accessible external surface of the package unless the following conditions are met, in which case the limit is 1000 millirem per hour:

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

(2) Provisions are made to secure the package so that its position within the vehicle remains fixed during transportation; and

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

(b) 200 millirem/hour at any point on the outer surface of the vehicle, including the upper and lower surfaces, or, in the case of an open vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load, and on the lower external surface of the vehicle;

(c) 10 millirem/hour at any point two meters from the vertical planes represented by the outer lateral surfaces of the vehicle, or, in the case of an open vehicle, at any point two meters from the vertical planes projected from the outer edges of the conveyance; and

(d) Two millirem/hour in any normally occupied positions of the vehicle, except that this provision does not apply to private motor carriers when persons occupying these positions are provided with special health supervision, personnel radiation exposure monitoring devices, and training in accordance with § 19.12 of this chapter.

### § 71.51 Additional requirements for Type B packages.

(a) A Type B package, in addition to satisfying the requirements of §§ 71.41 through 71.47 must be designed, constructed, and prepared for shipment so that under the tests specified in:

(1) Section 71.71 (Normal Conditions of Transport), there would be no loss or dispersal of radioactive contents, as demonstrated to a sensitivity of $10^{-6}$ $A_2$ per hour, no significant increase in external radiation levels, and no substantial reduction in the effectiveness of the packaging; and

(2) Section 71.73 (Hypothetical Accident Conditions), there would be no escape of kryption-85 exceeding 10,000 curies in one week, no escape of other radioactive material exceeding a total amount $A_2$ in one week, and no external radiation dose rate exceeding one

rem per hour at one meter from the external surface of the package.

(b) Compliance with the permitted activity release limits of paragraph (a) of this section must not depend upon filters or upon a mechanical cooling system.

### § 71.52 Exemption for low specific activity (LSA) packages.

A package need not satisfy the requirements of § 71.51 if it contains only low specific activity material and is transported as exclusive use, but is subject to §§ 71.41 through 71.47 of this part, including § 71.43(f).

### § 71.53 Fissile material exemptions.

The following packages are exempt from fissile material classification and from the fissile material standards of §§ 71.55 through 71.61, but are subject to all other requirements of this part:

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

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

(c) A package containing homogenous hydrogenous 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 five grams/liter; and

(3) The maximum mass of fissile radionuclides in the package is 800 grams, except for a mixture where the total mass of plutonium and uranium-233 exceeds one percent of the mass of uranium-235 the limit is 500 grams. If the material is transported in bulk, the quantity limitations apply to the vehicle, to a hold or compartment of an inland waterway craft, or to a hold, compartment, or defined deck area of a seagoing vessel; or

(d) A package containing uranium enriched in uranium-235 to a maximum of one percent by weight, and with a total plutonium and uranium-233 content of up to one percent 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; or

(e) A package containing any fissile material if it does not contain more than five 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; or

(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; or

(g) A package containing liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of two percent by weight, with total plutonium and uranium-233 not more than one-tenth percent of the mass of uranium-235.

### § 71.55 General requirements for all fissile material packages.

(a) A package used for the shipment of fissile material must be designed and constructed in accordance with §§ 71.41 through 71.47. When required by the total amount of radioactive material, a package used for the shipment of fissile material must also be designed and constructed in accordance with § 71.51.

(b) Except as provided in paragraph (c) of this section, a package used for the shipment of fissile material must be so designed and constructed and its contents so limited that it would be subcritical if water were to leak into the containment system or liquid contents were to leak out of the containment system so that, under the following conditions, maximum reactivity of the fissile material would be attained

(1) The most reactive credible configuration consistent with the chemical and physical form of the material.

(2) Moderation by water to the most reactive credible extent; and

(3) Close reflection by water on all sides.

(c) The Commission may approve exceptions to the requirements of para-

graph (b) of this section if the package incorporates special design features that ensure that no single packaging error would permit leakage, and if appropriate measures are taken before each shipment to ensure the containment system does not leak.

(d) A package used for the shipment of fissile material must be so designed and constructed and its contents so limited that under the tests specified in §71.71 (Normal Conditions of Transport):

(1) The contents would be subcritical;

(2) The geometric form of the package contents would not be substantially altered;

(3) There would be no leakage of water into the containment system unless, in the evaluation of undamaged packages under §§71.57(a), 71.59(b)(1), and 71.61(a), it has been assumed that moderation is present to such an extent as to cause maximum reactivity consistent with the chemical and physical form of the material; and

(4) There will be no substantial reduction in the effectiveness of the packaging, including:

(i) No more than five percent reduction in the total effective volume of the packaging on which nuclear safety is assessed;

(ii) No more than five percent reduction in the effective spacing between the fissile contents and the outer surface of the packaging; and

(iii) No occurrence of an aperture in the outer surface of the packaging large enough to permit the entry of a 10 cm (four in.) cube.

(e) A package used for the shipment of fissile material must be so designed and constructed and its contents so limited that under the tests specified in § 71.73 (Hypothetical Accident Conditions), the package would be subcritical. For this determination, it must be assumed that:

(1) The fissile material is in the most reactive credible configuration consistent with the damaged condition of the package and the chemical and physical form of the contents;

(2) Water moderation occurs to the most reactive credible extent consistent with the damaged condition of the package and the chemical and physical form of the contents; and

(3) There is reflection by water on all sides, as close as is consistent with the damaged condition of the package.

### § 71.57 Specific standards for a Fissile Class I package.

A Fissile Class I package must be so designed and constructed and its contents so limited that:

(a) Any number of undamaged packages would be subcritical in any arrangement and with optimum interspersed hydrogenous moderation unless there is a greater amount of interspersed moderation in the packaging, in which case the greater amount may be assumed for this determination; and

(b) Two hundred fifty (250) packages, if each package were subjected to the tests specified in § 71.73 (Hypothetical Accident Conditions), would be subcritical if stacked together in any arrangement, closely reflected on all sides of the stack by water, and with optimum interspersed hydrogenous moderation.

### § 71.59 Specific standards for a Fissile Class II package.

(a) A Fissile Class II package must be controlled by the carrier during transport. To provide this control, the designer of a Fissile Class II package must determine the allowable number of packages of that design which can be safely transported in a vehicle under the conditions specified in this section. This allowable number of packages determines the minimum transport index which the shipper of the package marks on the package label when the package is shipped. By limiting to 50 the total number of transport indexes in a vehicle or storage area, the carrier provides adequate criticality control.

(b) A Fissile Class II package must be designed and constructed and its contents so limited, and the allowable number of these packages in a Fissile Class II shipment so determined, that:

(1) Five times the allowable number of undamaged packages would be subcritical if stacked together in any ar-

rangement and closely reflected on all sides of the stack by water; and

(2) Twice the allowable number of packages, if each package were subjected to the tests specified in § 71.73 (Hypothetical Accident Conditions), would be subcritical if stacked together in any arrangement, closely reflected on all sides of the stack by water, and with optimum interspersed hydrogenous moderation.

(c) The transport index with respect to criticality control for each Fissile Class II package must be calculated by dividing the number 50 by the allowable number of Fissile Class II packages which may be transported together as determined under the limitations of paragraph (b) of this section. The transport index so determined must not exceed 10 and must be rounded up to the first decimal place.

### § 71.61 Specific standards for a Fissile Class III shipment.

A package for Fissile Class III shipment must be so designed and constructed and its contents so limited, and the number of packages in a Fissile Class III shipment must be so limited, that:

(a) Twice this number of undamaged packages would be subcritical if stacked together in any arrangement, assuming close reflection on all sides of the stack by water; and

(b) This number of packages would be subcritical if stacked together in any arrangement, closely reflected on all sides of the stack by water, and with optimum interspersed hydrogenous moderation. Except as permitted under § 71.41, each package must be considered to have been subjected to the tests specified in § 71.73 (Hypothetical Accident Conditions).

### § 71.63 Special requirements for plutonium shipments.

(a) Plutonium in excess of 20 curies per package must be shipped as a solid.

(b) Plutonium in excess of 20 curies per package must be packaged in a separate inner container placed within outer packaging that meets the requirements of Subparts E and F for packaging of material in normal form. If the entire package is subjected to the tests specified in § 71.71 (Normal Conditions of Transport), the separate inner container must not release plutonium, as demonstrated to a sensitivity of $10^{-6}$ $A_2$ per hour. If the entire package is subjected to the tests specified in § 71.73 (Hypothetical Accident Conditions), the separate inner container must restrict the loss of plutonium to not more than $A_2$ in one week. Solid plutonium in the following forms is exempt from the requirements of this paragraph:

(1) Reactor fuel elements;

(2) Metal or metal alloy; and

(3) Other plutonium bearing solids that the Commission determines should be exempt from the requirements of this section.

### § 71.65 Additional requirements.

The Commission may, by rule, regulation, or order, impose requirements upon any licensee in addition to those established in this part as it deems necessary or appropriate to protect health or to minimize danger to life or property.

## Subpart F—Package and Special Form Tests [2]

### § 71.71 Normal conditions of transport.

(a) *Evaluation.* Evaluation of each package design under normal conditions of transport must include a determination of the effect on that design of the conditions and tests specified in this section. Separate specimens may be used for the free drop test, the compression test, and the penetration test if each specimen is subjected to the water spray test before being subjected to any of the other tests.

(b) *Initial conditions.* With respect to the initial conditions for the tests in this section, the demonstration of compliance with the requirements of this Part must be based on the ambient temperature preceding and following the tests remaining constant at that value between −29°C (−20°F) and +38°C (100°F) which is most unfavor-

[2] The package standards related to the tests in this subpart are contained in Subpart E.

able for the feature under consideration. The initial internal pressure within the containment system must be considered to be the maximum normal operating pressure, unless a lower internal pressure consistent with the ambient temperature considered to precede and follow the tests is more unfavorable.

(c) *Conditions and tests*—(1) *Heat.* An ambient temperature of 38°C (100°F) in still air, and insolation according to the following table:

INSOLATION DATA

| Form and location of surface | Total insolation for a 12-hour period (g cal/cm²) |
|---|---|
| Flat surfaces transported horizontally | |
| —Base | None |
| —Other surfaces | 800 |
| Flat surfaces not transported horizontally | 200 |
| Curved surfaces | 400 |

(2) *Cold.* An ambient temperature of −40°C (−40°F) in still air and shade.

(3) *Reduced external pressure.* An external pressure of 24.5 kilopascal (3.5 psi) absolute.

(4) *Increased external pressure.* An external pressure of 140 kilopascal (20 psi) absolute.

(5) *Vibration.* Vibration normally incident to transport.

(6) *Water spray.* A water spray that simulates exposure to rainfall of approximately five cm (two in.) per hour for at least one hour.

(7) *Free drop.* Between 1½ and 2½ hours after the conclusion of the water spray test, a free drop through the distance specified below onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage is expected. For Fissile Class II packages, this free drop must be preceded by a free drop from a height of 0.3 m (one ft.) on each corner or, in the case of a cylindrical Fissile Class II package, onto each of the quarters of each rim.

CRITERIA FOR FREE DROP TEST (WEIGHT/DISTANCE)

| Package weight | | Free drop distance | |
|---|---|---|---|
| Kilograms | Pounds | Meters | Feet |
| 5,000 or less | (11,000) | 1.2 | (4) |
| 5,000 to 10,000 | (11,000 to 22,000) | 0.9 | (3) |
| 10,000 to 15,000 | (22,000 to 33,000) | 0.6 | (2) |
| More than 15,000 | (More than 33,000) | 0.3 | (1) |

(8) *Corner drop.* A free drop onto each corner of the package in succession, or in the case of a cylindrical package onto each quarter of each rim, from a height of 0.3 m (one ft.) onto a flat, essentially unyielding, horizontal surface. This test applies only to fiberboard or wood rectangular packages not exceeding 50 kg (110 pounds) and fiberboard or wood cylindrical packages not exceeding 100 kg (220 pounds).

(9) *Compression.* For packages weighing up to 5000 kg, the package must be subjected, for a period of 24 hours, to a compressive load applied uniformly to the top and bottom of the package in the position in which the package would normally be transported. The compressive load must be the greater of the following:

(i) The equivalent of five times the weight of the package; or

(ii) The equivalent of 12.75 kilopascal (1.85 lb/in²) multiplied by the vertically projected area of the package.

(10) *Penetration.* Impact of the hemispherical end of a vertical steel cylinder of 3.2 cm (1¼ in) diameter and six kg (13 lb) mass, dropped from a height of one m (40 in) onto the exposed surface of the package which is expected to be most vulnerable to puncture. The long axis of the cylinder must be perpendicular to the package surface.

**§ 71.73 Hypothetical accident conditions.**

(a) *Test procedures.* Evaluation for hypothetical accident conditions is to be based on sequential application of the tests specified in this section, in the order indicated, to determine their cumulative effect on a package or array of packages. An undamaged specimen must be used for the water immersion test specified in paragraph (c)(5) of this section.

(b) *Test conditions.* With respect to the initial conditions for the tests, except for the water immersion tests, to demonstrate compliance with the requirements of this part during testing, the ambient air temperature before and after the tests must remain constant at that value between −29°C (−20°F) and +38°C (100°F) which is most unfavorable for the feature under consideration. The initial internal pressure within the containment system must be the maximum normal operating pressure unless a lower internal pressure consistent with the ambient temperature assumed to precede and follow the tests is more unfavorable.

(c) *Tests.* Tests for hypothetical accident conditions must be conducted as follows:

(1) *Free Drop.* A free drop of the specimen through a distance of nine m (30 ft) onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage is expected.

(2) *Puncture.* A free drop of the specimen through a distance of one m (40 in) in a position for which maximum damage is expected, onto the upper end of a solid, vertical, cylindrical, mild steel bar mounted on an essentially unyielding, horizontal surface. The bar must be 15 cm (six in) in diameter, with the top horizontal and its edge rounded to a radius of not more than six mm (¼ in) and of a length as to cause maximum damage to the package, but not less than 20 cm (eight in) long. The long axis of the bar must be vertical.

(3) *Thermal.* Exposure of the whole specimen for not less than 30 minutes to a heat flux not less than that of a radiation environment of 800°C (1475°F) with an emissivity coefficient of at least 0.9. For purposes of calculation, the surface absorptivity must be either that value which the package may be expected to possess if exposed to a fire or 0.8, whichever is greater. In addition, when significant, convective heat input must be included on the basis of still, ambient air at 800°C (1475°F). Artificial cooling must not be applied after cessation of external heat input and any combustion of materials of construction must be allowed to proceed until it terminates naturally. The effects of solar radiation may be neglected prior to, during, and following the test.

(4) *Immersion—fissile material.* For fissile material, in those cases where water inleakage has not been assumed for criticality analysis, the specimen must be immersed under a head of water of at least 0.9 m (three ft) for a period of not less than eight hours and in the attitude for which maximum leakage is expected.

(5) *Immersion—all packages.* A separate, undamaged specimen must be subjected to water pressure equivalent to immersion under a head of water of at least 15 m (50 ft) for a period of not less than eight hours. For test purposes, an external pressure of water of 147 kilopascal (21 psi) gauge is considered to meet these conditions.

**§ 71.75 Qualification of special form radioactive material.**

(a) Evaluation of the contents of a single package for qualification as special form must include a determination of the effect on a specimen of those contents of the tests specified in § 71.77.

(1) Specimens (solid radioactive material or capsules) to be tested must be as normally prepared for loading in a single package, with the radioactive material duplicated as closely as practicable.

(2) A different specimen may be used for each of the tests.

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

(c) The specimen must not melt or disperse when subjected to the heat test.

(d) After each test, leak-tightness or indispersibility of the specimen must be determined by a method no less sensitive than the following leaching assessment procedure. 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 leak-tightness of $10^{-6}$ torr-l/s ($1.3 \times 10^{-6}$ atm cm³/s) (based on air at 25°C and one atmosphere differ-

ential pressure) for solid radioactive content, or $10^{-6}$ torr·l/s ($1.3 \times 10^{-6}$ atm cm³/s) for liquid or gaseous radioactive content.

(1) The specimen must 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 μmho/cm at 20°C (68°F). Encapsulated material is not subject to the seven-day requirement.

(2) The water with specimen must then be heated to a temperature of 50° ± 5°C (122° ± 9°F) and maintained at this temperature for four hours.

(3) The activity of the water must be determined at that time.

(4) The specimen must then be stored for at least seven days in still air of humidity not less than 90% and a temperature not less than 30°C (86°F).

(5) The specimen must then be immersed in water having a pH of 6-8 and a maximum conductivity of 10 μmho/cm at 20°C, and the water with specimen heated to 50° ± 5°C (122° ± 9°F) and maintained at this temperature for four hours.

(6) The activity of the water must be determined at that time.

(7) The activities determined in paragraphs (c)(3) and (6) of this section must not exceed 0.05 μCi.

[48 FR 35607, Aug. 5, 1983, 48 FR 38449, Aug. 24, 1983, 48 FR 51903, Nov. 15, 1983]

### § 71.77 Tests for special form radioactive material.

(a) *Impact test.* The specimen must fall onto a flat, horizontal, essentially unyielding surface from a height of not less than nine m (30 ft).

(b) *Percussion test.* The specimen must be placed on a sheet of lead which is supported by a smooth solid surface and 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 kg (three lb.) through one m (40 in.). The flat face of the billet must be 25 mm (one in.) in diameter with the edges rounded to a radius of three mm (0.12 in.) ± 0.3 mm (0.012 in.). The lead, of hardness number 3.5 to 4.5 on the Vickers scale and not more than 25 mm (one in.) thick, must cover an area greater than that covered by the specimen. A fresh surface of lead must be used for each impact. The billet must strike the specimen so as to cause maximum damage.

(c) *Bending test.* The test is applicable only to long, slender sources with both a minimum length of 10 cm (four in.) and a length to minimum width ratio not less than 10. The specimen must be rigidly clamped in a horizontal position so that one-half of its length protrudes from the face of the clamp. The orientation of the specimen must be such that the specimen will suffer maximum damage when its free end is struck by the flat face of a steel billet. The billet must strike the specimen so as to produce an impact equivalent to that resulting from a free vertical fall of 1.4 kg (three lb.) through one m (40 in.). The flat face of the billet must be 25 mm (one in.) in diameter with the edges rounded off to a radius of three mm (0.12 in.) ± 0.3 mm (0.012 in.).

(d) *Heat test.* The specimen must be heated to a temperature of not less than 800°C (1475°F) in an atmosphere which is essentially air, and held at that temperature for a period of 10 minutes and must then be allowed to cool.

[48 FR 35607, Aug. 5, 1983, 48 FR 38450, Aug. 24, 1983]

## Subpart G—Operating Controls and Procedures

### § 71.81 Applicability of operating controls and procedures.

A licensee subject to this part, who under a general or specific license transports licensed material or delivers licensed material to a carrier for transport, shall comply with the requirements of this Subpart G, with the quality assurance requirements of Subpart H of this part, and with the general provisions of Subpart A of this part.

### § 71.83 Assumptions as to unknown properties.

When the isotopic abundance, mass, concentration, degree of irradiation, degree of moderation, or other pertinent property of fissile material in any

package is not known, the licensee shall package the fissile material as if the unknown properties have credible values that will cause the maximum nuclear reactivity.

**§ 71.85 Preliminary determinations.**

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

(a) The licensee shall ascertain that there are no cracks, pinholes, uncontrolled voids, or other defects which could significantly reduce the effectiveness of the packaging;

(b) Where the maximum normal operating pressure will exceed 34.3 kilopascal (5 psi) gauge, the licensee shall test the containment system at an internal pressure at least 50% higher than the maximum normal operating pressure to verify the capability of that system to maintain its structural integrity at that pressure.

(c) The licensee shall conspicuously and durably mark the packaging with its model number, gross weight, and a package identification number assigned by the Nuclear Regulatory Commission. Prior to applying the model number, the licensee shall determine that the packaging has been fabricated in accordance with the design approved by the Commission.

**§ 71.87 Routine determinations.**

Prior to each shipment of licensed material, the licensee shall ensure that the package with its contents satisfies the applicable requirements of this part and of the license. The licensee shall determine that:

(a) The package is proper for the contents to be shipped;

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

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

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

(e) Any pressure relief device is operable and set in accordance with written procedures;

(f) The package has been loaded and closed in accordance with written procedures;

(g) For fissile material, any moderator or neutron absorber, if required, is present and in proper condition;

(h) Any structural part of the package which could be used to lift or tie down the package during transport is rendered inoperable for that purpose unless it satisfies the design requirements of § 71.45;

(i)(1) The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment is as low as reasonably achievable. 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 must be taken in the most appropriate locations to yield a representative assessment of the non-fixed contamination levels. Except as provided under paragraph (i)(2) of this section, the amount of radioactivity measured on any single wiping material when averaged over the surface wiped, must not exceed the limits given in Table V of this part 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 must be taken into account and in no case may the non-fixed contamination on the external surfaces of the package exceed ten times the limits listed in Table V.

TABLE V—REMOVABLE EXTERNAL RADIOACTIVE CONTAMINATION WIPE LIMITS

| Contaminant | Maximum permissible limits | |
|---|---|---|
| | μCi/cm² | dpm/cm² |
| 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 |

(2) In the case of packages transported as exclusive use shipments by rail or highway only, the non-fixed radioactive contamination at any time during transport must not exceed ten times the levels prescribed in paragraph (i)(1) of this section. The levels at the beginning of transport must not exceed the levels prescribed in paragraph (i)(1) of this section;

(j) External radiation levels around the package and around the vehicle, if applicable, will not exceed the limits specified in § 71.47 at any time during transportation; and

(k) Accessible package surface temperatures will not exceed the limits specified in § 71.43(g) at any time during transportation.

[48 FR 35607, Aug. 5, 1983; 48 FR 38450, Aug. 24, 1983]

**§ 71.88 Air transport of plutonium.**

(a) Notwithstanding the provisions of any general licenses and notwithstanding any exemptions stated directly in this part or included indirectly by citation of 49 CFR Chapter 1, as may be applicable, the licensee shall assure that plutonium in any form, whether for import, export, or domestic shipment, is not transported by air or delivered to a carrier for air transport unless:

(1) The plutonium is contained in a medical device designed for individual human application; or

(2) The plutonium is contained in a material in which the specific activity is not greater than 0.002 microcuries per gram of material and in which the radioactivity is essentially uniformly distributed; or

(3) The plutonium is shipped in a single package containing no more than an $A_2$ quantity of plutonium in any isotope or form and is shipped in accordance with § 71.5 of this part; or

(4) The plutonium is shipped in a package specifically authorized for the shipment of plutonium by air in the Certificate of Compliance for that package issued by the Commission.

(b) Nothing in paragraph (a) of this section is to be interpreted as removing or diminishing the requirements of § 73.24 of this chapter.

(c) There have been two orders issued by the NRC restricting the air shipment of plutonium in accordance with Pub. L. 94-79. The first order, issued on August 15, 1975 was superseded by the second order dated September 1, 1978, which has remained in effect since that time. As of the effective date of this rule, the outstanding order dated September 1, 1978 is revoked.

**§ 71.89 Opening instructions.**

Prior to delivery of a package to a carrier for transport, the licensee shall ensure that any special instructions needed to safely open the package have been sent to or otherwise made available to the consignee for the consignee's use in accordance with § 20.205 of this chapter.

**§ 71.91 Records.**

(a) Each licensee shall maintain for a period of two years after shipment a record of each shipment of licensed material not exempt under § 71.10, showing, where applicable:

(1) Identification of the packaging by model number;

(2) Verification that there are no significant defects in the packaging, as shipped;

(3) Volume and identification of coolant;

(4) Type and quantity of licensed material in each package, and the total quantity of each shipment;

(5) For each item of irradiated fissile material:

(i) Identification by model number and/or serial number;

(ii) Irradiation and decay history to the extent appropriate to demonstrate that its nuclear and thermal characteristics comply with license conditions; and

(iii) Any abnormal or unusual condition relevant to radiation safety.

(6) Date of the shipment;

(7) For Fissile Class III and for Type B packages, any special controls exercised;

(8) Name and address of the transferee;

(9) Address to which the shipment was made; and

(10) Results of the determinations required by § 71.87.

(b) The licensee shall make available to the Commission for inspection, upon reasonable notice, all records required by this part.

(c) The licensee shall maintain, during the life of the packaging to which they pertain, sufficient quality assurance records to furnish documentary evidence of the quality of packaging components which have safety significance and of services affecting quality. The records to be maintained include results of the determinations required by § 71.85, of monitoring, inspection, and auditing of work performance during the design, fabrication, assembly, testing, modification, maintenance, and repair of the packaging.

**§ 71.93 Inspection and tests.**

(a) The licensee shall permit the Commission at all reasonable times to inspect the licensed material, packaging, premises, and facilities in which the licensed material or packaging is used, produced, tested, stored, or shipped.

(b) The licensee shall perform, and permit the Commission to perform, tests as the Commission deems necessary or appropriate for the administration of the regulations in this chapter.

(c) The licensee shall notify the Director of the appropriate Nuclear Regulatory Commission Regional Office listed in Appendix A of Part 73 of this chapter at least 45 days prior to fabrication of a package to be used for the shipment of licensed material having a decay heat load in excess of five kilowatts or with a maximum normal operating pressure in excess of 103 kilopascal (15psi) gauge.

**§ 71.95 Reports.**

The licensee shall report to the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, within 30 days:

(a) Any instance in which there is significant reduction in the effectiveness of any authorized packaging during use; and

(b) Details of any defects with safety significance in the packaging after first use, with the means employed to repair the defects and prevent their recurrence.

**§ 71.97 Advance notification of shipment of nuclear waste.**

(a) Except as specified in paragraph (b) of this section, prior to the transport or delivery to a carrier for transport of licensed material outside the confines of the licensee's plant or other place of use or storage, each licensee shall provide advance notification to the governor of a state, or the governor's designee, of the shipment to, through, or across the boundry of the state.

(b) Advance notification is required only when:

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

(2) The licensed material other than irradiated fuel is being transported to, through, or across state boundaries to a disposal site or to a collection point for transport to a disposal site;

(3) The quantity of licensed material in a single package exceeds:

(i) 5,000 curies of special form radionuclides;

(ii) 5,000 curies of uncompressed gases of Argon-41, Krypton-85m, Krypton-87, Xenon-131m, or Xenon-135;

(iii) 50,000 curies of Argon-37, or of uncompressed gases of Krypton-85 or Xenon-133, or of Hydrogen-3 as a gas, as luminous paint, or adsorbed on solid material;

(iv) 20 curies of other non-special form radionuclides for which $A_2$ is less than or equal to four curies; or

(v) 200 curies of other non-special form radionuclides for which $A_2$ is greater than four curies; and

(4) The quantity of irradiated fuel is less than that subject to advance notification requirements of 10 CFR Part 73.

(c) *Procedures for submittin[illegible] vance notification.* (1) The no[illegible] tion must be made in writing [illegible] office of each appropriate governor [illegible] governor's designee and to the Director of the appropriate Nuclear Regulatory Commission Regional Office listed in Appendix A of Part 73 of this chapter.

(2) A notification delivered by mail must be postmarked at least seven days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

(3) A notification delivered by messenger must reach the office of the governor or of the governor's designee at least four days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

(i) A list of the names and mailing addresses of the governors' designees receiving advance notification of transportation of nuclear waste was published in the FEDERAL REGISTER on June 30, 1983 (48 FR 30221).

(ii) The list will be published annually in the FEDERAL REGISTER on or about June 30 to reflect any changes in information.

(iii) A list of the names and mailing addresses of the governors' designees is available upon request from the Director, Office of State Programs, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

(4) The licensee shall retain a copy of the notification as a record for one year.

(d) *Information to be furnished in advance notification of shipment.* Each advance notification of shipment of nuclear waste must contain the following information:

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

(2) A description of the nuclear waste contained in the shipment, as required by the regulations of DOT in 49 CFR 172.202 and 172.203(d);

(3) The point of origin of the shipment and the seven-day period during which departure of the shipment is estimated to occur;

(4) The seven-day period during which arrival of the shipment at state boundaries is estimated to occur;

(5) The destination of the shipment, and the seven-day period during which arrival of the shipment is estimated to occur; and

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

(e) *Revision notice.* A licensee who finds that schedule information previously furnished to a governor or governor's designee in accordance with this section will not be met, shall telephone a responsible individual in the office of the governor of the state or of the governor's designee and inform that individual of the extent of the delay beyond the schedule originally reported. The licensee shall maintain a record of the name of the individual contacted for one year.

(f) *Cancellation notice.* (1) Each licensee who cancels a nuclear waste shipment for which advance notification has been sent, shall send a cancellation notice to the governor of each state or the governor's designee previously notified and to the Director of the appropriate Nuclear Regulatory Commission Regional Office listed in Appendix A of Part 73 of this chapter.

(2) The licensee shall state in the notice that it is a cancellation and shall identify the advance notification which is being cancelled. The licensee shall retain a copy of the notice as a record for one year.

**§71.99 Violations.**

An injunction or other court order may be obtained prohibiting any violation of any provision of the Atomic Energy Act of 1954, as amended, (the Act) or Title II of the Energy Reorganization Act of 1974, as amended, or any regulation or order issued under the Acts. A court order may be obtained for the payment of a civil penalty imposed under section 234 of the Act for violation of sections 53, 57, 62, 63, 81, 82, 101, 103, 104, 107, or 109 of the Act, or section 206 of the Energy Reorganization Act of 1974, as amended; or any rule, regulation, or order issued under the Acts, or any term, condition, or limitation of any license issued under the Acts, or for any violation for which a license may be revoked under section 186 of the Act. Any person who willfully violates any provision of the Act or any regulation or order issued under the Acts may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

## Subpart H—Quality Assurance

### § 71.101 Quality assurance requirements.

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

(b) *Establishment of program.* Each licensee shall establish, maintain, and execute a quality assurance program satisfying each of the applicable criteria of this subpart, and satisfying any specific provisions which are applicable to the licensee's activities including procurement of packaging. The licensee shall apply the applicable criteria in a graded approach, and to an extent that is consistent with their importance to safety.

(c) *Approval of program.* Prior to the use of any package for the shipment of licensed material subject to this subpart, each licensee shall obtain Commission approval of its quality assurance program. Each licensee shall file a description of its quality assurance program, including a discussion of which requirements of this subpart are applicable and how they will be satisfied, with the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

(d) *Existing package designs.* The provisions of this paragraph deal with packages which have been approved for use in accordance with this part prior to January 1, 1979, and which have been designed in accordance with the provisions of this part in effect at the time of application for package approval. Those packages will be accepted as having been designed in accordance with a quality assurance program which satisfies the provisions of paragraph (b) of this section.

(e) *Existing packages.* The provisions of this paragraph deal with packages which have been approved for use in accordance with this part prior to January 1, 1979, have been at least partially fabricated prior to that date, and for which the fabrication is in accordance with the provisions of this part in effect at the time of application for approval of package design. These packages will be accepted as having been fabricated and assembled in accordance with a quality assurance program which satisfies the provisions of paragraph (b) of this section.

(f) *Previously approved programs.* A Commission-approved quality assurance program which satisfies the applicable criteria of Appendix B of Part 50 of this chapter and which is established, maintained, and executed with regard to transport packages will be accepted as satisfying the requirements of paragraph (b) of this section. Prior to first use, the licensee shall notify the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commisson, Washington, DC 20555, of its intent to apply its previously approved Appendix B program to transportation activities. The licensee shall identify the program by date of submittal to the Commission, Docket Number, and date of Commission approval.

### § 71.103 Quality assurance organization.

The licensee[1] shall be responsible for the establishment and execution of the quality assurance program. The licensee may delegate to others, such as contractors, agents, or consultants, the work of establishing and executing the quality assurance program, or any part of the quality assurance program, but shall retain responsibility for the program. The licensee shall clearly establish and delineate in writing the authority and duties of persons and organizations performing activities af-

[1] While the term "licensee" is used in these criteria, the requirements are applicable to whatever design, fabrication, assembly, and testing of the package is accomplished with respect to a package prior to the time a package approval is issued.

fecting the safety-related functions of structures, systems and components. These activities include performing the functions associated with attaining quality objectives and the quality assurance functions. The quality assurance functions are (a) assuring that an appropriate quality assurance program is established and effectively executed and (b) verifying, by procedures such as checking, auditing, and inspection, that activities affecting the safety-related functions have been correctly performed. The persons and organizations performing quality assurance functions must have sufficient authority and organizational freedom to identify quality problems; to initiate, recommend, or provide solutions; and to verify implementation of solutions. The persons and organizations performing quality assurance functions shall report to a management level which assures that the required authority and organizational freedom, including sufficient independence from cost and schedule when opposed to safety considerations, are provided. Because of the many variables involved, such as the number of personnel, the type of activity being performed, and the location or locations where activities are performed, the organizational structure for executing the quality assurance program may take various forms provided that the persons and organizations assigned the quality assurance functions have the required authority and organizational freedom. Irrespective of the organizational structure, the individual(s) assigned the responsibility for assuring effective execution of any portion of the quality assurance program at any location where activities subject to this section are being performed must have direct access to the levels of management necessary to perform this function.

**§ 71.105 Quality assurance program.**

(a) The licensee shall establish, at the earliest practicable time consistent with the schedule for accomplishing the activities, a quality assurance program which complies with the requirements of this section. The licensee shall document the quality assurance program by written procedures or instructions and shall carry out the program in accordance with those procedures throughout the period during which packaging is used. The licensee shall identify the material and components to be covered by the quality assurance program, the major organizations participating in the program, and the designated functions of these organizations.

(b) The licensee, through its quality assurance program, shall provide control over activities affecting the quality of the identified materials and components to an extent consistent with their importance to safety, and as necessary to assure conformance to the approved design of each individual package used for the shipment of radioactive material. The licensee shall assure that activities affecting quality are accomplished under suitably controlled conditions. Controlled conditions include the use of appropriate equipment; suitable environmental conditions for accomplishing the activity, such as adequate cleanliness; and assurance that all prerequisites for the given activity have been satisfied. The licensee shall take into account the need for special controls, processes, test equipment, tools and skills to attain the required quality, and the need for verification of quality by inspection and test.

(c) The licensee shall base the requirements and procedures of its quality assurance program on the following considerations concerning the complexity and proposed use of the package and its components:

(1) The impact of malfunction or failure of the item to safety;

(2) The design and fabrication complexity or uniqueness of the item;

(3) The need for special controls and surveillance over processes and equipment;

(4) The degree to which functional compliance can be demonstrated by inspection or test; and

(5) The quality history and degree of standardization of the item.

(d) The licensee shall provide for indoctrination and training of personnel performing activites affecting quality as necessary to assure that suitable proficiency is achieved and maintained. The licensee shall review the

status and adequacy of the quality assurance program at established intervals. Management of other organizations participating in the quality assurance program shall regularly review the status and adequacy of that part of the quality assurance program which they are executing.

**§ 71.107 Package design control.**

(a) The licensee shall establish measures to assure that applicable regulatory requirements and the package design, as specified in the license for those materials and components to which this section applies, are correctly translated into specifications, drawings, procedures, and instructions. These measures must include provisions to assure that appropriate quality standards are specified and included in design documents and that deviations from standards are controlled. Measures must be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the materials, parts, and components of the packaging.

(b) The licensee shall establish measures for the identification and control of design interfaces and for coordination among participating design organizations. These measures must include the establishment of written procedures among participating design organizations for the review, approval, release, distribution, and revision of documents involving design interfaces. The design control measures must provide for verifying or checking the adequacy of design, by methods such as design reviews, alternate or simplified calculational methods, or by a suitable testing program. For the verifying or checking process, the licensee shall designate individuals or groups other than those who were responsible for the original design, but who may be from the same organization. Where a test program is used to verify the adequacy of a specific design feature in lieu of other verifying or checking processes, the licensee shall include suitable qualification testing of a prototype or sample unit under the most adverse design conditions. The licensee shall apply design control measures to items such as the following: criticality physics, radiation shielding, stress, thermal, hydraulic, and accident analyses; compatibility of materials, accessibility for inservice inspection, maintenance, and repair; features to facilitate decontamination; and delineation of acceptance criteria for inspections tests.

(c) The licensee shall subject design changes, including field changes, to design control measures commensurate with those applied to the original design. Changes in the conditions specified in the package approval require NRC approval.

[48 FR 35607, Aug. 5, 1983. 48 FR 38450, Aug. 24, 1983]

**§ 71.109 Procurement document control.**

The licensee shall establish measures to assure adequate quality is required in the documents for procurement of material, equipment, and services, whether purchased by the licensee or by its contractors or subcontractors. To the extent necessary, the licensee shall require contractors or subcontractors to provide a quality assurance program consistent with the applicable provisions of this part.

**§ 71.111 Instructions, procedures, and drawings.**

The licensee shall prescribe activities affecting quality by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall require that these instructions, procedures, and drawings be followed. The instructions, procedures, and drawings must include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished.

**§ 71.113 Document control.**

The licensee shall establish measures to control the issuance of documents such as instructions, procedures, and drawings, including changes, which prescribe all activities affecting quality. These measures must assure that documents, including changes, are reviewed for adequacy, approved for release by authorized personnel, and distributed and used at

the location where the prescribed activity is performed. These measures must assure that changes to documents are reviewed and approved.

**§ 71.115 Control of purchased material, equipment, and services.**

(a) The licensee shall establish measures to assure that purchased material, equipment, and services, whether purchased directly or through contractors and subcontractors, conform to the procurement documents. These measures must include provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor or subcontractor, inspection at the contractor or subcontractor source, and examination of products upon delivery.

(b) The licensee shall have available documentary evidence that material and equipment conform to the procurement specifications prior to installation or use of the material and equipment. The licensee shall retain or have available this documentary evidence for the life of the package to which it applies. The licensee shall assure that the evidence is sufficient to identify the specific requirements met by the purchased material and equipment.

(c) The licensee or designee shall assess the effectiveness of the control of quality by contractors and subcontractors at intervals consistent with the importance, complexity, and quantity of the product or services.

**§ 71.117 Identification and control of materials, parts, and components.**

The licensee shall establish measures for the identification and control of materials, parts, and components. These measures must assure that identification of the item is maintained by heat number, part number, or other appropriate means, either on the item or on records traceable to the item, as required throughout fabrication, installation, and use of the item. These identification and control measures must be designed to prevent the use of incorrect or defective materials, parts, and components.

**§ 71.119 Control of special processes.**

The licensee shall establish measures to assure that special processes, including welding, heat treating, and nondestructive testing, are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements.

**§ 71.121 Internal inspection.**

The licensee shall establish and execute a program for inspection of activities affecting quality by or for the organization performing the activity to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity. The inspection must be performed by individuals other than those who performed the activity being inspected. Examination, measurements, or tests of material or products processed must be performed for each work operation where necessary to assure quality. If direct inspection of processed material or products is not carried out, indirect control by monitoring processing methods, equipment, and personnel must be provided. Both inspection and process monitoring must be provided when quality control is inadequate without both. If mandatory inspection hold points, which require witnessing or inspecting by the licensee's designated representative and beyond which work should not proceed without the consent of its designated representative, are required, the specific hold points must be indicated in appropriate documents.

**§ 71.123 Test control.**

The licensee shall establish a test program to assure that all testing required to demonstrate that the packaging components will perform satisfactorily in service is identified and performed in accordance with written test procedures which incorporate the requirements of this part and the requirements and acceptance limits contained in the package approval. The test procedures must include provisions for assuring that all prerequisites for the given test are met, that adequate test instrumentation is avail-

able and used, and that the test is performed under suitable environmental conditions. The licensee shall document and evaluate the test results to assure that test requirements have been satisfied.

**§ 71.125 Control of measuring and test equipment.**

The licensee shall establish measures to assure that tools, gages, instruments, and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated, and adjusted at specified times to maintain accuracy within necessary limits.

**§ 71.127 Handling, storage, and shipping control.**

The licensee shall establish measures to control, in accordance with instructions, the handling, storage, shipping, cleaning, and preservation of materials and equipment to be used in packaging to prevent damage or deterioration. When necessary for particular products, special protective environments, such as inert gas atmosphere, and specific moisture content and temperature levels must be specified and provided.

**§ 71.129 Inspection, test, and operating status.**

(a) The licensee shall establish measures to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the packaging. These measures must provide for the identification of items which have satisfactorily passed required inspections and tests where necessary to preclude inadvertent bypassing of the inspections and tests.

(b) The licensee shall establish measures to identify the operating status of components of the packaging, such as tagging valves and switches, to prevent inadvertent operation.

**§ 71.131 Nonconforming materials, parts, or components.**

The licensee shall establish measures to control materials, parts, or components which do not conform to the licensee's requirements in order to prevent their inadvertent use or installation. These measures must include, as appropriate, procedures for identification, documentation, segregation, disposition, and notification to affected organizations. Nonconforming items must be reviewed and accepted, rejected, repaired, or reworked in accordance with documented procedures.

**§ 71.133 Corrective action.**

The licensee shall establish measures to assure that conditions adverse to quality, such as deficiencies, deviations, defective material and equipment, and nonconformances, are promptly identified and corrected. In the case of a significant condition adverse to quality, the measures must assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken must be documented and reported to appropriate levels of management.

**§ 71.135 Quality assurance records.**

(a) The licensee shall maintain sufficient written records to furnish evidence of activities affecting quality. The records must include the following: design records, records of use and the results of reviews, inspections, tests, audits, monitoring of work performance, and materials analyses. The records must include closely related data such as qualifications of personnel, procedures, and equipment. Inspection and test records must, at a minimum, identify the inspector or data recorder, the type of observation, the results, the acceptability, and the action taken in connection with any deficiencies noted. Records must be identifiable and retrievable. Records pertaining to the fabrication of the package must be retained for the life of the package to which they apply. Records pertaining to the use of the package for shipment of radioactive material must be retained for a period of two years after the shipment.

(b) The licensee shall establish a records retention program which is consistent with the applicable regula-

tions, designating factors such as duration, location, and assigned responsibility.

§ 71.137 Audits.

The licensee shall carry out a comprehensive system of planned and periodic audits to verify compliance with all aspects of the quality assurance program and to determine the effectiveness of the program. The audits must be performed in accordance with written procedures or checklists by appropriately trained personnel not having direct responsibilities in the areas being audited. Audited results must be documented and reviewed by management having responsibility in the area audited. Follow-up action, including re-audit of deficient areas, must be taken where indicated.

## APPENDIX A—DETERMINATION OF $A_1$ AND $A_2$

### I. SINGLE RADIONUCLIDES

(1) For a single radionuclide of known identity, the values of $A_1$ and $A_2$ are taken from Table A-1 if listed there. The values $A_1$ and $A_2$ in Table A-1 are also applicable for radionuclides contained in ($\alpha$, n) or ($\gamma$, n) neutron sources.

(2) For any single radionuclide whose identity is known but which is not listed in Table A-1, the values of $A_1$ and $A_2$ are determined according to the following procedure:

(a) If the radionuclide emits only one type of radiation, $A_1$ is determined according to the rules in paragraphs (i), (ii), (iii) and (iv) of this paragraph. 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 Ci. If a parent nuclide decays into a shorter lived daughter with 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.

(i) For gamma emitters, $A_1$ is determined by the expression:

$$A_1 = \frac{9}{\Gamma} \text{ curies}$$

where $\Gamma$ is the gamma-ray constant, corresponding to the dose in R/h at 1 m per Ci, the number 9 results from the choice of 1 rem/h at a distance of 3 m as the reference dose-equivalent rate.

(ii) For X-ray emitters, $A_1$ is determined by the atomic number of the nuclide:

for $Z \leq 55 - A_1 = 1000$ Ci

for $Z > 55 - A_1 = 200$ Ci

where Z is the atomic number of the nuclide.

(iii) For beta emitters, $A_1$ is determined by the maximum beta energy ($E_{max}$) according to Table A-2.

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

$A_1 = 1000\ A_2$

where $A_2$ is the value listed in Table A-3.

(b) $A_2$ is the more restrictive of the following two values:

(i) The corresponding $A_1$; and

(ii) The value $A_2$ obtained from Table A-3.

(3) For any single radionuclide whose identity is unknown, the value of $A_1$ is taken to be two Ci and the value of $A_2$ is taken to be 0.002 Ci. However, if the atomic number of the radionuclide is known to be less than 82, the value of $A_1$ is taken to be 10 Ci and the value of $A_2$ is taken to be 0.4 Ci.

### II. MIXTURES OF RADIONUCLIDES, INCLUDING RADIOACTIVE DECAY CHAINS

(1) For mixed fission products the following activity limits may be assumed if a detailed analysis of the mixture is not carried out:

$A_1 = 10$ Ci

$A_2 = 0.4$ Ci

(2) A single radioactive decay chain is considered to be a single radionuclide when the radionuclides are present in their naturally occurring proportions 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 from Table A-1 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 considered. 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 are known, the permissible activity of each radionuclide $R_1$, $R_2$ . . . $R_n$ is such that $F_1 + F_2 + \ldots F_n$ is not greater than unity, where

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

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

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

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

(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 paragraph (3) is applied to establish the values of $A_1$ or $A_2$ as appropriate. All the radionuclides whose individual activities are not known (their total activity will, however, be known) are classed in a single group and the most restrictive value of $A_1$ and $A_2$ applicable to any one of them is used as the value of $A_1$ or $A_2$ in the denominator of the fraction.

(5) Where the identity of each radionuclide is known but the individual activity of none of the radionuclides is known, the most restrictive value of $A_1$ or $A_2$ applicable to any one of the radionuclides present is adopted as the applicable value.

(6) When the identity of none of the nuclides is known, the value of $A_1$ is taken to be two Ci and the value of $A_2$ is taken to be 0.002 Ci. However, if alpha emitters are known to be absent, the value of $A_2$ is taken to be 0.4 Ci.

## TABLE A-1—$A_1$ AND $A_2$ VALUES FOR RADIONUCLIDES

(See footnotes at end of Table A-1)

| Symbol of radionuclide | Element and atomic number | $A_1$(Ci) | $A_2$(Ci) | Specific activity (Ci/g) |
|---|---|---|---|---|
| $^{227}Ac$ | Actinium (89) | 1000 | 0.003 | $7.2 \times 10$ |
| $^{228}Ac$ | | 10 | 4 | $2.2 \times 10^{4}$ |
| $^{105}Ag$ | Silver (47) | 40 | 40 | $3.1 \times 10^{4}$ |
| $^{110m}Ag$ | | 7 | 7 | $4.7 \times 10^{3}$ |
| $^{111}Ag$ | | 100 | 20 | $1.6 \times 10^{5}$ |
| $^{241}Am$ | Americium (95) | 8 | 0.008 | 3.2 |
| $^{243}Am$ | | 8 | 0.008 | $1.9 \times 10^{-1}$ |
| $^{37}Ar$ (compressed or uncompressed)* | Argon (18) | 1000 | 1000 | $1.0 \times 10^{5}$ |
| $^{41}Ar$ (uncompressed)* | | 20 | 20 | $4.3 \times 10^{7}$ |
| $^{41}Ar$ (compressed)* | | 1 | 1 | $4.3 \times 10^{7}$ |
| $^{73}As$ | Arsenic (33) | 1000 | 400 | $2.4 \times 10^{4}$ |
| $^{74}As$ | | 20 | 20 | $1.0 \times 10^{5}$ |
| $^{76}As$ | | 10 | 10 | $1.6 \times 10^{5}$ |
| $^{77}As$ | | 300 | 20 | $1.1 \times 10^{6}$ |
| $^{211}At$ | Astatine (85) | 200 | 7 | $2.1 \times 10^{6}$ |
| $^{193}Au$ | Gold (79) | 200 | 200 | $9.3 \times 10^{5}$ |
| $^{196}Au$ | | 30 | 30 | $1.2 \times 10^{5}$ |
| $^{198}Au$ | | 40 | 20 | $2.5 \times 10^{5}$ |
| $^{199}Au$ | | 200 | 25 | $2.1 \times 10^{5}$ |
| $^{131}Ba$ | Barium (56) | 40 | 40 | $8.7 \times 10^{4}$ |
| $^{133}Ba$ | | 40 | 10 | $4.0 \times 10^{3}$ |
| $^{140}Ba$ | | 20 | 20 | $7.3 \times 10^{4}$ |
| $^{7}Be$ | Beryllium (4) | 300 | 300 | $3.5 \times 10^{5}$ |
| $^{206}Bi$ | Bismuth (83) | 5 | 5 | $9.9 \times 10^{4}$ |
| $^{207}Bi$ | | 10 | 25 | $2.2 \times 10^{2}$ |
| $^{210}Bi$ (mas) | | 100 | 4 | $1.2 \times 10^{5}$ |
| $^{212}Bi$ | | 6 | 6 | $1.5 \times 10^{7}$ |

TABLE A-1—$A_1$ AND $A_2$ VALUES FOR RADIONUCLIDES—Continued

(See footnotes at end of Table A-1)

| Symbol of radionuclide | Element and atomic number | $A_1$(Ci) | $A_2$(Ci) | Specific activity (Ci/g) |
|---|---|---|---|---|
| $^{249}Bk$ | Berkelium (97) | 1000 | 1 | $1.8 \times 10^{3}$ |
| $^{77}Br$ | Bromine (35) | 70 | 25 | $7.1 \times 10^{5}$ |
| $^{82}Br$ | | 6 | 6 | [illegible] $\times 10^{5}$ |
| $^{11}C$ | Carbon (6) | 20 | 20 | [illegible] $10^{5}$ |
| $^{14}C$ | | 1000 | 60 | 4.6 |
| $^{45}Ca$ | Calcium (20) | 1000 | 25 | $1.9 \times 10^{4}$ |
| $^{47}Ca$ | | 20 | 20 | $5.9 \times 10^{5}$ |
| $^{109}Cd$ | Cadmium (48) | 1000 | 70 | $2.6 \times 10^{3}$ |
| $^{115m}Cd$ | | 30 | 30 | $2.6 \times 10^{4}$ |
| $^{115}Cd$ | | 80 | 20 | $5.1 \times 10^{5}$ |
| $^{139}Ce$ | Cerium (58) | 100 | 100 | $6.5 \times 10^{3}$ |
| $^{141}Ce$ | | 300 | 25 | $2.8 \times 10^{4}$ |
| $^{143}Ce$ | | 60 | 20 | $6.6 \times 10^{5}$ |
| $^{144}Ce$ | | 10 | 7 | $3.2 \times 10^{3}$ |
| $^{249}Cf$ | Californium (98) | 2 | 0.002 | 3.1 |
| $^{250}Cf$ | | 7 | 0.007 | $1.3 \times 10^{2}$ |
| $^{252}Cf$ | | 2 | 0.009 | $6.5 \times 10^{2}$ |
| $^{36}Cl$ | Chlorine (17) | 300 | 10 | $3.2 \times 10^{2}$ |
| $^{38}Cl$ | | 10 | 10 | $1.3 \times 10^{6}$ |
| $^{242}Cm$ | Curium (96) | 200 | 0.2 | $3.3 \times 10^{3}$ |
| $^{243}Cm$ | | 9 | 0.009 | $4.2 \times 10$ |
| $^{244}Cm$ | | 10 | 0.01 | $8.2 \times 10$ |
| $^{245}Cm$ | | 6 | 0.006 | $1.0 \times 10^{-1}$ |
| $^{246}Cm$ | | 6 | 0.006 | $3.6 \times 10^{-1}$ |
| $^{58}Co$ | Cobalt (27) | 5 | 5 | $3.0 \times 10^{4}$ |
| $^{57}Co$ | | 90 | 90 | $8.5 \times 10^{3}$ |
| $^{58m}Co$ | | 1000 | 1000 | $5.9 \times 10^{6}$ |
| $^{58}Co$ | | 20 | 20 | $3.1 \times 10^{4}$ |
| $^{60}Co$ | | 7 | 7 | $1.1 \times 10^{3}$ |
| $^{51}Cr$ | Chromium (24) | 600 | 600 | $9.2 \times 10^{4}$ |
| $^{129}Cs$ | Cesium (55) | 40 | 40 | $7.6 \times 10^{5}$ |
| $^{131}Cs$ | | 1000 | 1000 | $1.0 \times 10^{5}$ |
| $^{134m}Cs$ | | 1000 | 10 | $7.4 \times 10^{6}$ |
| $^{134}Cs$ | | 10 | 10 | $1.2 \times 10^{3}$ |
| $^{135}Cs$ | | 1000 | 25 | $8.8 \times 10^{-4}$ |
| $^{136}Cs$ | | 7 | 7 | $7.4 \times 10^{4}$ |
| $^{137}Cs$ | | 30 | 10 | $9.8 \times 10$ |
| $^{64}Cu$ | Copper (29) | 80 | 25 | $3.8 \times 10^{6}$ |
| $^{67}Cu$ | | 200 | 25 | $7.9 \times 10^{5}$ |
| $^{165}Dy$ | Dysprosium (66) | 100 | 20 | $8.2 \times 10^{6}$ |
| $^{166}Dy$ | | 1000 | 200 | $2.3 \times 10^{5}$ |
| $^{169}Er$ | Erbium (68) | 1000 | 25 | $6.2 \times 10^{4}$ |
| $^{171}Er$ | | 50 | 20 | $2.4 \times 10^{6}$ |
| $^{152m}Eu$ | Europium (63) | 30 | 30 | $2.2 \times 10^{6}$ |
| $^{152}Eu$ | | 20 | 10 | $1.9 \times 10^{2}$ |
| $^{154}Eu$ | | 10 | 5 | $1.5 \times 10^{2}$ |
| $^{155}Eu$ | | 400 | 60 | $1.4 \times 10^{3}$ |
| $^{18}F$ | Fluorine (9) | 20 | 20 | $9.3 \times 10^{7}$ |
| $^{52}Fe$ | Iron (26) | 5 | 5 | $7.3 \times 10^{6}$ |
| $^{55}Fe$ | | 1000 | 1000 | $2.2 \times 10^{3}$ |
| $^{59}Fe$ | | 10 | 10 | $4.9 \times 10^{4}$ |

TABLE A-1—$A_1$ AND $A_2$ VALUES FOR RADIONUCLIDES—Continued

(See footnotes at end of Table A-1)

| Symbol of radionuclide | Element and atomic number | $A_1$(Ci) | $A_2$(Ci) | Specific activity (Ci/g) |
|---|---|---|---|---|
| $^{67}Ga$ | Gallium (31) | 100 | 100 | $6.0 \times 10^{5}$ |
| $^{68}Ga$ | | 20 | 20 | $4.0 \times 10^{7}$ |
| $^{72}Ga$ | | 7 | 7 | $3.1 \times 10^{6}$ |
| $^{153}Gd$ | Gadolinium (64) | 200 | 100 | $3.6 \times 10^{3}$ |
| $^{159}Gd$ | | 300 | 20 | $1.1 \times 10^{6}$ |
| $^{68}Ge$ | Germanium (32) | 20 | 10 | $7.0 \times 10^{3}$ |
| $^{71}Ge$ | | 1000 | 1000 | $1.6 \times 10^{5}$ |
| $^{3}H$ | Hydrogen (1) see T-Tritium | | | |
| $^{181}Hf$ | Hafnium (72) | 30 | 25 | $1.6 \times 10^{4}$ |
| $^{197m}Hg$ | Mercury (80) | 200 | 200 | $6.6 \times 10^{5}$ |
| $^{197}Hg$ | | 200 | 200 | $2.5 \times 10^{5}$ |
| $^{203}Hg$ | | 80 | 25 | $1.4 \times 10^{4}$ |
| $^{166}Ho$ | Holmium (67) | 30 | 30 | $6.9 \times 10^{5}$ |
| $^{123}I$ | Iodine (53) | 50 | 50 | $1.9 \times 10^{6}$ |
| $^{125}I$ | | 1000 | 70 | $1.7 \times 10^{4}$ |
| $^{126}I$ | | 40 | 10 | $7.8 \times 10^{4}$ |
| $^{129}I$ | | 1000 | 2 | $1.6 \times 10^{-4}$ |
| $^{131}I$ | | 40 | 10 | $1.2 \times 10^{6}$ |
| $^{132}I$ | | 7 | 7 | $1.1 \times 10^{7}$ |
| $^{133}I$ | | 30 | 10 | $1.1 \times 10^{6}$ |
| $^{134}I$ | | 8 | 8 | $2.7 \times 10^{7}$ |
| $^{135}I$ | | 10 | 10 | $3.5 \times 10^{6}$ |
| $^{111}In$ | Indium (49) | 30 | 25 | $4.2 \times 10^{5}$ |
| $^{113m}In$ | | 80 | 60 | $1.6 \times 10^{7}$ |
| $^{114m}In$ | | 30 | 20 | $2.3 \times 10^{4}$ |
| $^{115m}In$ | | 100 | 20 | $6.1 \times 10^{6}$ |
| $^{190}Ir$ | Indium (77) | 10 | 10 | $8.2 \times 10^{4}$ |
| $^{192}Ir$ | | 20 | 10 | $9.1 \times 10^{3}$ |
| $^{194}Ir$ | | 10 | 10 | $8.5 \times 10^{5}$ |
| $^{42}K$ | Potassium (19) | 10 | 10 | $6.0 \times 10^{6}$ |
| $^{43}K$ | | 20 | 10 | $3.3 \times 10^{6}$ |
| $^{85m}Kr$, (uncompressed)* | Krypton (36) | 100 | 100 | $8.4 \times 10^{6}$ |
| $^{85m}Kr$, (compressed)* | | 3 | 3 | $8.4 \times 10^{6}$ |
| $^{85}Kr$, (uncompressed)* | | 1000 | 1000 | $4.0 \times 10^{2}$ |
| $^{85}Kr$, (compressed)* | | 5 | 5 | $4.0 \times 10^{2}$ |
| $^{87}Kr$, (uncompressed)* | | 20 | 20 | $2.8 \times 10^{7}$ |
| $^{87}Kr$, (compressed)* | | 0.6 | 0.6 | $2.8 \times 10^{7}$ |
| $^{140}La$ | Lanthanum (57) | 30 | 30 | $5.6 \times 10^{5}$ |
| LSA | Low specific activity material—see § 71.4. | | | |
| $^{177}Lu$ | Lutetium (71) | 300 | 25 | $1.1 \times 10^{5}$ |
| MFP | Mixed fission products | 10 | 0.4 | |
| $^{28}Mg$ | Magnesium (12) | 8 | 8 | $5.2 \times 10^{6}$ |
| $^{52}Mn$ | Manganese (25) | 5 | 5 | $4.4 \times 10^{5}$ |
| $^{54}Mn$ | | 20 | 20 | $8.3 \times 10^{3}$ |
| $^{56}Mn$ | | 5 | 5 | $2.2 \times 10^{7}$ |
| $^{99}Mo$ | Molybdenum (42) | 100 | 20 | $4.7 \times 10^{5}$ |
| $^{13}N$ | Nitrogen (7) | 20 | 10 | $1.5 \times 10^{9}$ |
| $^{22}Na$ | Sodium (11) | 8 | 8 | $8.3 \times 10^{3}$ |

TABLE A-1—$A_1$ AND $A_2$ VALUES FOR RADIONUCLIDES—Continued

(See footnotes at end of Table A-1)

| Symbol of radionuclide | Element and atomic number | $A_1$(Ci) | $A_2$(Ci) | Specific activity (Ci/g) |
|---|---|---|---|---|
| $^{24}Na$ | | 5 | 5 | $8.7 \times 10^{6}$ |
| $^{93m}Nb$ | Niobium (41) | 1000 | 200 | $1.1 \times 10^{3}$ |
| $^{95}Nb$ | | 20 | 20 | $3.9 \times 10^{4}$ |
| $^{97}Nb$ | | 20 | 20 | $2.6 \times 10^{7}$ |
| $^{147}Nd$ | Neodymium (60) | 100 | 20 | $8.0 \times 10^{4}$ |
| $^{149}Nd$ | | 30 | 20 | $1.1 \times 10^{7}$ |
| $^{59}Ni$ | Nickel (28) | 1000 | 900 | $8.1 \times 10^{-2}$ |
| $^{63}Ni$ | | 1000 | 100 | $4.6 \times 10$ |
| $^{65}Ni$ | | 10 | 10 | $1.9 \times 10^{7}$ |
| $^{237}Np$ | Neptunium (93) | 5 | 0.005 | $6.9 \times 10^{-4}$ |
| $^{239}Np$ | | 200 | 25 | $2.3 \times 10^{5}$ |
| $^{185}Os$ | Osmium (76) | 20 | 20 | $7.3 \times 10^{3}$ |
| $^{191}Os$ | | 600 | 200 | $4.6 \times 10^{4}$ |
| $^{191m}Os$ | | 200 | 200 | $1.2 \times 10^{6}$ |
| $^{193}Os$ | | 100 | 20 | $5.3 \times 10^{5}$ |
| $^{32}P$ | Phosphorus (15) | 30 | 30 | $2.9 \times 10^{5}$ |
| $^{230}Pa$ | Protactinium (91) | 20 | 0.8 | $3.2 \times 10^{4}$ |
| $^{231}Pa$ | | 2 | 0.002 | $4.5 \times 10^{-2}$ |
| $^{233}Pa$ | | 100 | 100 | $2.1 \times 10^{4}$ |
| $^{201}Pb$ | Lead (82) | 20 | 20 | $1.7 \times 10^{6}$ |
| $^{210}Pb$ | | 100 | 0.2 | $8.8 \times 10$ |
| $^{212}Pb$ | | 6 | 5 | $1.4 \times 10^{6}$ |
| $^{103}Pd$ | Palladium (46) | 1000 | 700 | $7.5 \times 10^{4}$ |
| $^{109}Pd$ | | 100 | 20 | $2.1 \times 10^{6}$ |
| $^{147}Pm$ | Promethium (61) | 1000 | 25 | $9.4 \times 10^{2}$ |
| $^{149}Pm$ | | 100 | 20 | $4.2 \times 10^{5}$ |
| $^{210}Po$ | Polonium (84) | 200 | 0.2 | $4.5 \times 10^{3}$ |
| $^{142}Pr$ | Praseodymium (59) | 10 | 10 | $1.2 \times 10^{4}$ |
| $^{143}Pr$ | | 300 | 20 | $6.6 \times 10^{4}$ |
| $^{191}Pt$ | Platinum (78) | 100 | 100 | $2.3 \times 10^{5}$ |
| $^{193m}Pt$ | | 200 | 200 | $2.0 \times 10^{5}$ |
| $^{197m}Pt$ | | 300 | 20 | $1.2 \times 10^{7}$ |
| $^{197}Pt$ | | 300 | 20 | $8.8 \times 10^{5}$ |
| $^{238}Pu$ | Plutonium (94) | 3 | 0.003 | $1.7 \times 10$ |
| $^{239}Pu$ | | 2 | 0.002 | $6.2 \times 10^{-2}$ |
| $^{240}Pu$ | | 2 | 0.002 | $2.3 \times 10^{-1}$ |
| $^{241}Pu$ | | 1000 | 0.1 | $1.1 \times 10^{2}$ |
| $^{242}Pu$ | | 3 | 0.003 | $3.9 \times 10^{-3}$ |
| $^{223}Ra$ | Radium (88) | 50 | 0.2 | $5.0 \times 10^{4}$ |
| $^{224}Ra$ | | 6 | 0.5 | $1.6 \times 10^{5}$ |
| $^{226}Ra$ | | 10 | 0.05 | 1.0 |
| $^{228}Ra$ | | 10 | 0.05 | $2.3 \times 10^{2}$ |
| $^{81}Rb$ | Rubidium (37) | 30 | 25 | $8.2 \times 10^{4}$ |
| $^{86}Rb$ | | 30 | 30 | $8.1 \times 10^{4}$ |
| $^{87}Rb$ | | Unlimited | Unlimited | $6.6 \times 10^{-8}$ |
| Rb (natural) | | Unlimited | Unlimited | $1.8 \times 10^{-7}$ |
| $^{186}Re$ | Rhenium (75) | 100 | 20 | $1.9 \times 10^{5}$ |
| $^{187}Re$ | | Unlimited | Unlimited | $3.8 \times 10^{-8}$ |
| $^{188}Re$ | | 10 | 10 | $1.0 \times 10^{6}$ |
| Re (natural) | | Unlimited | Unlimited | $2.4 \times 10^{-8}$ |
| $^{103m}Rh$ | Rhodium (45) | 1000 | 1000 | $3.2 \times 10^{7}$ |

TABLE A-1—$A_1$ AND $A_2$ VALUES FOR RADIONUCLIDES—Continued

(See footnotes at end of Table A-1)

| Symbol of radionuclide | Element and atomic number | $A_1$(Ci) | $A_2$(Ci) | Specific activity (Ci/g) |
|---|---|---|---|---|
| $^{105}Rh$ | | 200 | 25 | $8.2 \times 10^{3}$ |
| $^{222}Rn$ | Radon (86) | 10 | 2 | $1.5 \times 10^{3}$ |
| $^{97}Ru$ | Ruthenium (44) | 80 | 80 | $5.5 \times 10^{3}$ |
| $^{103}Ru$ | | 30 | 25 | $3.2 \times 10^{4}$ |
| $^{105}Ru$ | | 20 | 20 | $6.6 \times 10^{4}$ |
| $^{106}Ru$ | | 10 | 7 | $3.4 \times 10^{3}$ |
| $^{35}S$ | Sulphur (16) | 1000 | 60 | $4.3 \times 10^{4}$ |
| $^{122}Sb$ | Antimony (51) | 30 | 30 | $3.9 \times 10^{3}$ |
| $^{124}Sb$ | | 5 | 5 | $1.8 \times 10^{4}$ |
| $^{125}Sb$ | | 40 | 25 | $1.4 \times 10^{3}$ |
| $^{46}Sc$ | Scandium (21) | 8 | 8 | $3.4 \times 10^{4}$ |
| $^{47}Sc$ | | 200 | 20 | $8.2 \times 10^{3}$ |
| $^{48}Sc$ | | 5 | 5 | $1.5 \times 10^{4}$ |
| $^{75}Se$ | Selenium (34) | 40 | 40 | $1.4 \times 10^{4}$ |
| $^{31}Si$ | Silicon (14) | 100 | 20 | $3.9 \times 10^{7}$ |
| $^{147}Sm$ | Samarium (62) | Unlimited | Unlimited | $2.0 \times 10^{-8}$ |
| $^{151}Sm$ | | 1000 | 90 | $2.6 \times 10$ |
| $^{153}Sm$ | | 300 | 20 | $4.4 \times 10^{3}$ |
| $^{113}Sn$ | Tin (50) | 60 | 60 | $1.0 \times 10^{4}$ |
| $^{119m}Sn$ | | 100 | 100 | $4.4 \times 10^{3}$ |
| $^{125}Sn$ | | 10 | 10 | $1.1 \times 10^{5}$ |
| $^{85m}Sr$ | Strontium (38) | 80 | 80 | $3.2 \times 10^{7}$ |
| $^{85}Sr$ | | 30 | 30 | $2.4 \times 10^{4}$ |
| $^{87m}Sr$ | | 50 | 50 | $1.2 \times 10^{7}$ |
| $^{89}Sr$ | | 100 | 10 | $2.9 \times 10^{4}$ |
| $^{90}Sr$ | | 10 | 0.4 | $1.5 \times 10^{2}$ |
| $^{91}Sr$ | | 10 | 10 | $3.6 \times 10^{4}$ |
| $^{92}Sr$ | | 10 | 10 | $1.3 \times 10^{7}$ |
| $^{3}T$ (uncompressed)* | Tritium (1) | 1000 | 1000 | $9.7 \times 10^{3}$ |
| $^{3}T$ (compressed)* | | 1000 | 1000 | $9.7 \times 10^{3}$ |
| $^{3}T$ (activated luminous paint) | | 1000 | 1000 | $9.7 \times 10^{3}$ |
| $^{3}T$ (adsorbed on solid carrier) | | 1000 | 1000 | $9.7 \times 10^{3}$ |
| $^{3}T$ (tritiated water) | | 1000 | 1000 | $9.7 \times 10^{3}$ |
| $^{3}T$ (other forms) | | 20 | 20 | $9.7 \times 10^{3}$ |
| $^{182}Ta$ | Tantalum (73) | 20 | 20 | $6.2 \times 10^{3}$ |
| $^{160}Tb$ | Terbium (65) | 20 | 10 | $1.1 \times 10^{4}$ |
| $^{96m}Tc$ | Technetium (43) | 1000 | 1000 | $3.8 \times 10^{7}$ |
| $^{96}Tc$ | | 6 | 6 | $3.2 \times 10^{3}$ |
| $^{97m}Tc$ | | 1000 | 200 | $1.5 \times 10^{4}$ |
| $^{97}Tc$ | | 1000 | 400 | $1.4 \times 10^{-3}$ |
| $^{98m}Tc$ | | 100 | 100 | $5.2 \times 10^{4}$ |
| $^{99}Tc$ | | 1000 | 25 | $1.7 \times 10^{-2}$ |
| $^{125m}Te$ | Tellurium (52) | 1000 | 100 | $1.8 \times 10^{4}$ |
| $^{127M}Te$ | | 300 | 20 | $4.0 \times 10^{4}$ |
| $^{127}Te$ | | 300 | 20 | $2.6 \times 10^{4}$ |
| $^{129M}Te$ | | 30 | 10 | $2.5 \times 10^{4}$ |
| $^{129}Te$ | | 100 | 20 | $2.0 \times 10^{7}$ |
| $^{131m}Te$ | | 10 | 10 | $8.0 \times 10^{3}$ |
| $^{132}Te$ | | 7 | 7 | $3.1 \times 10^{5}$ |

TABLE A-1—$A_1$ AND $A_2$ VALUES FOR RADIONUCLIDES—Continued

(See footnotes at end of Table A-1)

| Symbol of radionuclide | Element and atomic number | $A_1$(Ci) | $A_2$(Ci) | Specific activity (Ci/g) |
|---|---|---|---|---|
| $^{227}Th$ | Thorium (90) | 200 | 0.2 | $3.2 \times 10^{4}$ |
| $^{228}Th$ | | 6 | 0.008 | $8.3 \times 10^{2}$ |
| $^{230}Th$ | | 3 | 0.003 | $1.9 \times 10^{-2}$ |
| $^{231}Th$ | | 1000 | 25 | $5.3 \times 10^{5}$ |
| $^{232}Th$ | | Unlimited | Unlimited | $1.1 \times 10^{-7}$ |
| $^{234}Th$ | | 10 | 10 | $2.3 \times 10^{4}$ |
| Th (natural) | | Unlimited | Unlimited | $2.2 \times 10^{-7}$ |
| Th (irradiated)** | | | | |
| $^{200}Tl$ | Thallium (81) | 20 | 20 | $5.8 \times 10^{5}$ |
| $^{201}Tl$ | | 200 | 200 | $2.2 \times 10^{5}$ |
| $^{202}Tl$ | | 40 | 40 | $5.4 \times 10^{4}$ |
| $^{204}Tl$ | | 300 | 10 | $4.3 \times 10^{2}$ |
| $^{170}Tm$ | Thulium (69) | 300 | 10 | $6.0 \times 10^{3}$ |
| $^{171}Tm$ | | 1000 | 100 | $1.1 \times 10^{3}$ |
| $^{230}U$ | Uranium (92) | 100 | 0.1 | $2.7 \times 10^{4}$ |
| $^{232}U$ | | 30 | 0.03 | $2.1 \times 10$ |
| $^{233}U$ | | 100 | 0.1 | $9.5 \times 10^{-3}$ |
| $^{234}U$ | | 100 | 0.1 | $6.2 \times 10^{-3}$ |
| $^{235}U$ | | 100 | 0.2 | $2.1 \times 10^{-6}$ |
| $^{236}U$ | | 200 | 0.2 | $6.3 \times 10^{-5}$ |
| $^{238}U$ | | Unlimited | Unlimited | $3.3 \times 10^{-7}$ |
| U (natural) | | Unlimited | Unlimited | (See Table A-4) |
| U (enriched) | | | | |
| < 20 percent | | Unlimited | Unlimited | (See Table A-4) |
| 20 percent or greater | | 100 | 0.1 | (See Table A-4) |
| U (depleted) | | Unlimited | Unlimited | (See Table A-4) |
| U (irradiated)*** | | | | |
| $^{48}V$ | Vanadium (23) | 6 | 6 | $1.7 \times 10^{5}$ |
| $^{181}W$ | Tungsten (74) | 200 | 100 | $5.0 \times 10^{3}$ |
| $^{185}W$ | | 1000 | 25 | $9.7 \times 10^{3}$ |
| $^{187}W$ | | 40 | 20 | $7.0 \times 10^{5}$ |
| $^{127}Xe$ (uncompressed)* | Xenon (54) | 70 | 70 | $2.8 \times 10^{4}$ |
| $^{127}Xe$ (compressed)* | | 5 | 5 | $2.8 \times 10^{4}$ |
| $^{131m}Xe$ (compressed)* | | 10 | 10 | $1.0 \times 10^{3}$ |
| $^{131m}Xe$ (uncompressed)* | | 100 | 100 | $1.0 \times 10^{5}$ |
| $^{133}Xe$ (uncompressed)* | | 1000 | 1000 | $1.9 \times 10^{5}$ |
| $^{133}Xe$ (compressed)* | | 5 | 5 | $1.9 \times 10^{5}$ |
| $^{135}Xe$ (uncompressed)* | | 70 | 70 | $2.5 \times 10^{5}$ |
| $^{135}Xe$ (compressed)* | | 2 | 2 | $2.5 \times 10^{5}$ |
| $^{87}Y$ | Yttrium (39) | 20 | 20 | $4.5 \times 10$ |
| $^{90}Y$ | | 10 | 10 | $2.5 \times 10^{5}$ |
| $^{91m}Y$ | | 30 | 30 | $4.1 \times 10^{7}$ |
| $^{91}Y$ | | 30 | 30 | $2.5 \times 10^{4}$ |

END