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DEPARTMENT OF TRANSPORTATION

Research and Special Programs Administration

49 CFR Parts 171, 172, 173, 174, 175, 176, 177, and 178

[Docket No. HM–169A; Amdt. Nos. 171–135, 172–143, 173–244, 174–80, 175–53, 176–37, 177–85, 178–109]

RIN 2137–AB60

Hazardous Materials Transportation Regulations; Compatibility with Regulations of the International Atomic Energy Agency

AGENCY: Research and Special Programs Administration (RSPA), DOT.

ACTION: Final rule.

SUMMARY: This final rule amends the Hazardous Materials Regulations pertaining to the transportation of radioactive materials to harmonize them with those of the International Atomic Energy Agency (IAEA) and, thus, most major nuclear nations of the world. Several substantive changes are made to provide a more uniform degree of safety for various types of shipments, such as requiring offerors and carriers to maintain written radiation protection programs, revisions to the definition and packaging for low specific activity radioactive materials, and requiring use of the International System of Units for the measurement of activity in a package of radioactive material. However, the basic standards for packaging radioactive materials remain unchanged. The intended effect of this rulemaking is to increase the level of safety and facilitate international commerce concerning the transportation of radioactive materials. Elsewhere in todays **Federal Register**, the Nuclear Regulatory Commission (NRC) has published a corresponding final rule to its transportation regulations found in 10 CFR Part 71.

DATES: Effective date. The effective date of these amendments is April 1, 1996.

Incorporation by reference date: The incorporation by reference of certain publications listed in this amendment is approved by the Director of the Federal Register as of April 1, 1996.

Compliance date. Voluntary compliance with these regulations, as amended herein, is authorized as of November 1, 1995.

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SUPPLEMENTARY INFORMATION:

I. Background

On November 14, 1989, RSPA published a notice of proposed rulemaking (NPRM; Notice No. 89–8; 54 FR 47454) under Docket HM–169A proposing to amend the Hazardous Materials Regulations (HMR; 49 CFR Parts 171–180) pertaining to the transportation of radioactive materials so that the HMR would be consistent with IAEA Safety Series No. 6, ''Regulations for the Safe Transport of Radioactive Material Revised 1985 and Supplemented 1988'' (IAEA SS6–85). An extension of time to file comments until May 11, 1990, was published in the **Federal Register** on February 8, 1990 (55 FR 4445).

II. Comments Received

A total of 56 comments were received, representing the views of Federal and State agencies, power utilities, and offerors and carriers of radioactive materials. All commenters were in general agreement with the NPRM, but expressed concerns on various topics. Several commenters requested that RSPA issue a second NPRM incorporating the knowledge gained from the comments received. RSPA does not agree that a second NPRM is needed or desirable. RSPA believes that the issues addressed in this Docket should not be delayed further and that the merits of comments have been addressed in this final rule, alleviating the need for another NPRM to be issued under Docket HM–169A.

RSPA received many comments that were editorial and general in nature and some comments that raised issues beyond the scope of this rulemaking. All of the comments that correctly pointed out editorial errors in the NPRM are adopted. Comments that are beyond the scope of this rulemaking are not adopted, and, generally, have not been discussed in this preamble. Other comments to Notice No. 89–8 are discussed in the applicable parts of Section III and IV of this preamble.

III. Discussion of Amendments

While this final rule amends extensive portions of the regulations dealing with the transportation of radioactive materials, the majority of the changes are not substantive. Many changes involve the revision of section and paragraph numbers and their references and the incorporation of the International System of Units (SI units) for radiological measurements, where appropriate. In addition, some sections are rewritten to provide clarity without changing their subject matter. Although not all of 49 CFR Part 173, Subpart I, entitled ''Radioactive Materials'', has been amended, it is reissued in its entirety for convenience of the reader. Substantive changes are discussed in the following paragraphs.

A. Radiation Protection

On January 27, 1987, the Environmental Protection Agency (EPA) published a document entitled, ''Radiation Protection Guidance to Federal Agencies for Occupational Exposure: Recommendations Approved by the President.'' Among its recommendations, EPA specified that no exposure should occur unless an overall benefit is derived from the activity causing the exposure; that radiation doses must be maintained as low as is reasonably achievable (ALARA); that the annual effective dose equivalent be limited to 50 millisieverts (mSv) (5 rem) to the whole body, 150 mSv (15 rem) to lens of the eye, and 500 mSv (50 rem) to any other organ, tissue or extremity of the body; that occupational exposure for individuals under the age of 18 not exceed 1/10 of the values recommended for radiation workers; and that the dose equivalent to an embryo-fetus as a result of the occupational exposure of a woman who has declared herself to be pregnant should not exceed 5 mSv (500 mrem) during the entire gestation period.

In establishing the requirements for radiation protection programs in this rule, RSPA believes they are consistent with the intent of the requirements issued by EPA. RSPA views the radiation exposures being received by workers and the general public as offset by beneficial uses of radioactive material. These benefits are not possible without transportation. The required radiation protection program must keep all radiation exposures as low as reasonably achievable (ALARA), which is also a basic requirement of the EPA guidance. The radiation dose limit specified for workers is 50 mSv (5 rem) per year, which is the whole body dose limit specified in the EPA guidance; and similarly workers are not subject to a radiation protection program if the expected annual radiation dose is less than 5 mSv (500 mrem). The radiation dose limit for an embryo-fetus carried by a female worker who has declared her pregnancy is consistent with the EPA requirements. The radiation protection program has elements that involve training workers, maintaining records, and providing certain kinds of information to workers and to RSPA.

The EPA guidance provides different limits for organs and parts of the body, which include concerns for radiation doses that may result from radioactive material being deposited in a person's body. RSPA recognizes the existence of these more detailed requirements that typically relate to fixed facilities. However, for purposes of transportation, RSPA believes the whole body radiation dose due to external radiation exposure is the primary concern and adequately represents the potential risk to workers and members of the general public. Therefore, these regulations impose requirements only on the whole body radiation doses received due to exposure to external sources of ionizing radiation.

In the NPRM, RSPA proposed to satisfy the 50 mSv (5 rem) per year EPA dose limitation for occupationally exposed workers by establishing a three-tiered radiation protection program based on provisions in the IAEA transportation regulations. In the proposed rule, no special work patterns or monitoring would have been required for workers receiving a dose less than 5 mSv (500 mrem) per year. For doses between 5 mSv (500 mrem) and 15 mSv (1.5 rem) per year, carriers and other persons would have to determine if special work patterns or monitoring were necessary. For expected doses above 15 mSv (1.5 rem) up to 50 mSv (5 rem), individuals would need to be provided radiation dosimetry devices for monitoring doses.

Most commenters agreed in principle that radiation protection requirements should be extended to transportation and transportation-related operations, but objected to some of the mandatory provisions. Several commenters were concerned about the ability of offerors and carriers to determine their applicable ''tier''. The Department of Energy (DOE) stated that carriers need criteria to evaluate the three levels. DuPont stated that transport index is the only quantitative information available to carriers in order to determine if a radiation protection program is necessary. The Hazardous Materials Advisory Council (HMAC) stated that, in making an initial assessment of exposure to determine the appropriate tier of control, a carrier has only a single piece of information to work from: the transport index (TI). HMAC went on to say that DOT should offer specific implementing guidelines on developing a radiation protection program. Other commenters stated that specific guidelines should be issued in order for offerors and carriers to develop a radiation protection program.

On the basis of the data submitted to the docket, RSPA concurs with those commenters who stated that the three-tiered approach for determining the scope of a radiation protection program is too difficult and costly for most offerors and carriers to implement. RSPA also concurs with those commenters that stated that TI is the best data available to offerors and carriers in order to determine if a radiation protection program is necessary. Therefore, RSPA is replacing the three-tier approach with a radiation protection program based on the total TI that is handled by an offeror or carrier during a period of one year. A radioactive materials transportation activity involving handling packages with TI's totaling 200 or more in a period of one year is established as a threshold condition which would require a hazardous materials (hazmat) employer to implement a radiation protection program. Persons are excepted from the requirements of establishing a radiation protection program if they handle less than 200 TI in any 12-month period. Therefore, persons who offer or accept only WHITE-I or limited quantity radioactive material packages are excepted from the radiation protection program requirements.

Another exception for not establishing a radiation protection program is established for offeror and carriers who handle more than 200 TI per year. This exception involves having a qualified radiation protection specialist to evaluate the doses that workers might receive during a period of one year while handling radioactive materials during transportation. If the evaluation shows that no worker would be expected to receive a dose of 5 mSv (500 mrem) in one year, then a radiation protection program is not required.

If an offeror or carrier of radioactive materials is excepted from establishing a radiation protection program, they must maintain certain records and make them available to RSPA or other authorized officials upon request. The records must show that either the total TI of packages transported in any 12-month period is less than 200, or that the current radioactive materials transport activities are the same as the activities that were reviewed by a competent radiation protection specialist whose evaluation demonstrated that no worker will receive a dose exceeding 5 mSv (500 mrem) in one year and that radiation doses to members of the general public are acceptably low.

The 200–TI threshold for relief from the radiation protection program requirements is based on findings in NUREG/CR–2200, ''Radiation Exposure of Transportation Workers Handling Large Quantities of Radioactive Packages.'' This study determined that the highest exposure from transporting radioactive materials was from handling of the packages, and found that the average exposure index (i.e., the collective dose to workers per total TI) for handling packages was about 0.45 person mrem/TI. This value is supported by findings presented in NUREG–0154, ''Exposure of Airport Workers to Radiation From Shipments of Radioactive Materials''. This value is also supported by data on file from holders of exemptions E–10045 and E–8308. Using the value of 0.45 (person mrem/TI) for those activities involving an annual TI of 200 or less, annual radiation doses should not exceed the recommended levels for members of the general public.

Offerors and carriers subject to the radiation protection program are required to develop and implement a written radiation protection program that prohibits a person from receiving an occupational exposure (dose) of 12.5 mSv (1.25 rem) in any 3-month period or 50 mSv (5 rem) in any 12-month period. To document that no person has received such a dose, all occupationally exposed hazmat employees are required to be monitored by radiation dosimetry devices such as film badges. In conjunction with hazardous materials safety training requirements of § 172.704, hazmat employers of occupationally exposed hazmat employees must implement procedures to reduce the exposures of hazmat employees to ionizing radiation to levels that are as low as reasonably achievable (ALARA). In addition, radiation protection programs must be developed and implemented in accordance with the EPA guidance. In order to provide offerors and carriers with the flexibility to tailor a radiation protection program to their specific operations, and because no set of guidelines could accommodate all of the possible activities that are involved in the transportation of radioactive materials, RSPA refrains from imposing a specific set of guidelines on developing a radiation protection program. RSPA understands the complexities involved in developing and instituting a radiation protection program and is delaying compliance with these requirements until October 1, 1997.

Several commenters claimed that a radiation protection program based on the ALARA principles would be ''too subjective'' and would be difficult both to apply and to enforce and, thus,

should not be adopted as a mandatory requirement in the HMR. RSPA acknowledges the difficulties of enforcing a radiation protection program that is based on the principles of ALARA. However, the EPA guidance, and the radiation programs requirements of the NRC and the Occupational Safety and Health Administration are based on ALARA principles. The principle of reduction of exposure to levels that are ALARA is typically implemented in two different ways. First, it is applied to the design of the facility so as to reduce, prospectively, the anticipated exposure of workers. Second, it is applied to actual operations; that is work practices are designed and carried out to reduce the exposure of workers. Effective implementation of the ALARA principles involves: education of workers concerning the health risks of exposure to radiation; training in regulatory requirements and procedures to control exposure levels and doses; and management and supervision of radiation protection activities, including the choice and implementation of radiation control measures. RSPA believes that adoption of the ALARA principles as a requirement in the HMR is an important facet of a radiation protection program, and, therefore, is not adopting these commenters request to adopt the ALARA principles as a non-mandatory requirement.

As noted above, radiation protection programs must be developed and implemented in accordance with the EPA guidance. In order to make it easier for the regulated community to comply with the radiation protection program requirements, RSPA has extracted from the EPA guidance and placed in the HMR some of the more important aspects of the EPA guidance. These include the limits on exposure to pregnant females and persons under the age of 18, and recordkeeping requirements.

Though RSPA is not imposing a specific set of guidelines to be followed in developing a radiation protection program, RSPA is referencing two reports from the National Council on Radiation Protection and Measurements (NCRP) which provide useful information in developing and implementing a radiation protection program. NCRP Report No. 116, titled ''Limitation of Exposure to Ionizing Radiation'', addresses limits for workers as well as for members of the general public. That report is essentially consistent with the most recent guidance from the International Commission on Radiological Protection (ICRP) which is also being incorporated into the basic radiation protection standards of the IAEA. In NCRP Report No. 116 the annual radiation dose limit for workers is essentially 20 mSv (2 rem) and the limit for members of the general public is 1 mSv (100 mrem) per year. The report contains many of the requirements in the 1987 EPA Guidance, and 10 CFR Part 20. The recommendations in NCRP Report No. 116 cover existing and probable future radiation dose limits and practices for regulating the radiation doses.

The other NCRP Report, No. 59 ''Operational Radiation Safety Program'' (1978) is recommended as guidance to be tailored to the needs of a hazmat employer when a radiation protection program needs to be established. The report contains information about organization, activities, emergency planning, equipment, reporting and documentation, facilities, training, personnel qualifications, etc. The information is useful for developing radiation protection programs for small and large corporations.

In this final rule, the radiation dose limit for members of the general public is the same as those proposed in the NPRM, (i.e., 5 mSv (500 mrem)) per year. This value is consistent with the Federal Radiation Council (FRC) guidance of 1960 and was consistent with the NRC's 10 CFR Part 20 in 1989. Subsequently, NRC revised 10 CFR Part 20 and their annual limit for exposures to members of the general public is now 1 mSv (100 mrem) per year. EPA is currently developing guidance for regulatory agencies for limiting radiation exposures for members of the general public, and the anticipated annual limit is expected to be 1 mSv (100 mrem) with no single practice or activity causing a person to receive more than a minor fraction of that limit. In a future rulemaking, RSPA will address the new guidance from EPA concerning exposures of the general public.

A number of commenters questioned the relationship between radiation exposure limits proposed in the NPRM and the minimum separation distances required in the HMR. The DOE noted that, if changes are not made, the occupational dose limits proposed in § 173.405 would be quickly exceeded as a result of the modal requirements in Parts 174–177. RSPA acknowledges the differences between the dose limits established in the radiation protection programs and the dose rate limits related to TI separation distances set forth in Parts 174, 175, 176, and 177. However, RSPA believes that requirements addressing both annual dose limits and TI/separation distances are essential in establishing effective radiation protection standards. Minimization of annual doses received by occupationally exposed workers and members of the general public is the primary objective in any adequate radiation protection program. Although TI/separation distance requirements do not, in themselves, assure that annual dose requirements will be met, they comprise minimal operational requirements that must also be satisfied. A carrier may have to impose more restrictive limits in its radiation protection program.

A number of commenters asked if radiation protection requirements apply only to workers preparing the material for shipment, to workers receiving packages, or to carriers during transport. This confusion arose because the radiation protection program requirements were proposed to be adopted in Part 173. Accordingly, RSPA is clarifying the applicability of the requirements for the radiation protection program by moving the requirements to subpart I in Part 172 in order to clarify that the requirements apply to both offerors and carriers of radioactive materials. In addition, applicable sections have been added to the modal parts in Parts 174, 175, 176 and 177, in order to ensure that carriers are aware of the radiation protection requirements in subpart I of part 172. RSPA agrees with a number of commenters that provisions established in this final rule should not replace or duplicate existing approved radiation protection program requirements. Accordingly, RSPA is adding an exception which states that any radiation protection program already in place and approved by an appropriate federal or state agency is deemed adequate to meet the radiation protection requirements of the HMR.

Many commenters were concerned about the definitions of several terms, particularly ''transport worker'' and ''general public''. The phrase ''transport worker'' is being replaced by the phrase ''hazmat employee'', which was defined in § 171.8 as a result of Docket HM–126F. In the context of radiation protection programs, this term is further refined to include only ''occupationally exposed hazmat employees.'' In this final rule, the term ''general public'' is defined in § 171.8 to include persons other than occupationally exposed hazmat employees.

Several comments compared the requirement to provide training as to the hazards of radioactive materials and the provisions in Part 172, Subpart H to provide safety training to all hazmat employees. As specified in Part 172,

subpart H, hazmat employees must receive safety training in all classes of hazardous materials with which they work; therefore, the requirement proposed in § 173.405(c) to train persons as to the hazards of radioactive materials is no longer necessary and is not adopted in this final rule.

B. Low Specific Activity Material and Surface Contaminated Objects

Based on the provisions contained in IAEA SS6–85, RSPA proposed to revise comprehensively the regulations for the shipment of low specific activity (LSA) radioactive material. A new designation for radioactive material called surface contaminated object (SCO) was also proposed. Unlike LSA, which requires a uniform distribution of radioactive material within the material; materials classified as SCO are not inherently radioactive, rather they are objects with radioactive contamination on their surfaces.

The proposals for LSA and SCO consisted of the following:

1. An expansion of the LSA definition to include new types of material;
2. A new definition of ''surface contaminated object'' (SCO) that is treated in a manner similar to LSA material; and
3. An increase of specific activity limits for nondispersible, nonrespirable forms of LSA material while at the same time limiting the quantity of LSA material that can be shipped in other than a Type B package to 2 times the A_1 value ($2A_1$) for the specific nuclide being transported.

A new type of package, called the ''industrial package'', was also proposed for the handling of LSA and surface contaminated objects (SCO). Three categories of industrial packages (IP), IP–1, IP–2 and IP–3, were proposed. RSPA proposed to require these packages for the shipment of LSA and SCO instead of currently required packages (i.e., either a modified Type A package or a strong, tight (nonspecification) package.

Commenters raised concerns over various aspects of the proposed regulation of LSA materials, including the proposed definitions, potential increases in packaging costs for LSA materials, and the proposed removal of an exclusive use shipment exception in § 173.425(b). Particularly, commenters objected to requiring Type B packages for the shipments of LSA exceeding 2 times the A_1 value of the radionuclide. Commenters claimed that the $2A_1$ limit was not a close approximation of the IAEA limit of 1 rem/h at 3 meters. Commenters claimed that a closer approximation of the IAEA limit is 4 times the A_1 value ($4A_1$). Commenters stated that the IAEA limit of 1 rem/h at 3 meters, a limit $4A_1$, or a combination of the two, should replace the proposed $2A_1$ limit. One commenter stated that the IAEA limit was impractical and unworkable and favored adoption of a multiple of a A_1 approach (i.e., $4A_1$). However, the Department of Energy stated that the IAEA approach is very practical and that it has been implemented internationally. Another commenter stated that industry can implement the IAEA limit of 1 rem/h at 3 meters and requested that RSPA replace the $2A_1$ limit with the IAEA limit.

The IAEA added the limit of 10 mSv/hour (1 rem/hour) at 3 meters for the radiation level from the unshielded contents of LSA and SCO packages not designed to withstand accidents. This radiation level limit controls the external radiation exposures to individuals if an LSA package is severely damaged in a transportation accident.

The IAEA limit considers the loss of package shielding during an accident, but it does not consider the possibility that a package's contents might be released and redistributed, causing a reduction in self-shielding of the contents. The reduction in self-shielding could result in potential accident radiation levels that significantly exceed IAEA's 10 mSv/hour (1 rem /hour) at 3 meters limit.

The IAEA dose rate limit provides a significant added degree of protection over the 1973 IAEA regulations (which specify no quantity limit for LSA packages). RSPA and NRC did not believe, however that the IAEA limit provided the same level of safety for all types of LSA material, particularly for relatively large quantities of radioactive materials contained in dispersible LSA materials (e.g., resins and other media used in liquid radioactive waste treatment).

In lieu of the radiation level limit, RSPA and NRC proposed a $2A_1$ quantity limit for all LSA packages. Although this proposal addressed the accident concern by directly limiting package quantity, it was not compatible with the IAEA provisions. Both agencies received many comments on the proposed $2A_1$ quantity limit that objected to the impacts on occupational dose and shipping costs. Further, the Advisory Committee on Reactor Safeguards (ACRS) issued a letter report, dated December 19, 1994, recommending, inter alia, that the requirements again be reevaluated with the objective of making them equivalent to the IAEA regulations.

After consideration of ACRS and industry comments, RSPA and NRC have agreed to adopt the IAEA LSA provisions. Accordingly, the final rule imposes a limit on the external radiation level at 3 meters from the unshielded contents of LSA–I, LSA–II, LSA–III, SCO–1, or SCO–II packages of 10 mSv/hour (1 rem/hour).

Numerous comments addressed the proposed removal of the present authorization for use of Type A packages and exclusive use shipments of strong, tight containers for LSA′materials. Commenters stated that LSA materials pose a minor risk to the public and that there is no justifiable safety reason to replace the currently authorized packagings with the industrial packagings. Commenters also cited an increase in the packaging costs for LSA materials without an equivalent increase in public safety if the Type A, and strong, tight packagings were not allowed for transportation of LSA material. Upon further review of the proposal to remove the Type A packaging and the strong, tight packaging as authorized packagings for LSA materials, RSPA has decided to retain these packagings for the transportation of LSA material because the benefits associated with the proposal are not commensurate with the increase in costs. However, industrial packagings are added as an authorized packaging for LSA material and SCO in order to provide the industry greater flexibility and to facilitate international commerce.

Several comments addressed the definition of LSA material and SCO. One commenter requested that dewatered material be defined as a solid for LSA–II. LSA–II is expected to include nuclear reactor process wastes, including filter sludge, absorbed liquids, and lower activity resins. RSPA and NRC believe the LSA–II specific activity limit for solids, rather than that for liquids, applies to dewatered resins. Therefore, RSPA and NRC see no need to define dewatered material as a solid for LSA–II.

Commenters were also concerned about their ability to measure the contamination on inaccessible surfaces of SCO's. Though it is impossible to directly measure the fixed contamination on an inaccessible surface of an object, it is possible to determine the contamination level on the inaccessible surface through physical measurements and mathematical analysis (involving geometric and attenuation factors) of the object.

One commenter compared the new limits for SCO with existing limits for

LSA material in § 173.403 and claimed there was a reduction in the specific activity limits in the proposed rule. RSPA notes that the proposed and final rules for shipping SCO–I contain the same limits for fixed radioactive surface contamination as were present in the previous definition of LSA material. The difference in the SCO–I definition is the addition of the normal package limits on removable external contamination. The change from existing regulations is the addition of the definition of SCO–II for solid objects which are more heavily contaminated on their surfaces then SCO–I objects.

Some commenters also requested that the definition of LSA–I be expanded to include material generated from the extraction of uranium or thorium. Another commenter recommended that the term ''contaminated soil'' in LSA–I be expanded to include ''soil, earth, concrete rubble and other bulk debris.'' Another commenter expressed concern that mill tailings exceeding 10E–6A_2/g could not be shipped in bulk under the proposed rule. The commenter recommended that either mill tailings be specifically included in the definition of LSA–I without an activity or concentration limit, or the specific activity limit for LSA–I be increased to 4x10E–6A_2/g.

RSPA agrees that ore-like materials (materials with highly uniform distribution of small quantities of radionuclides) should be transported as LSA–I material. Accordingly, the definition of LSA–I is expanded from ''contaminated soil'' to ''contaminated soil, mill tailings, concrete rubble and other debris * * *'' RSPA believes that mill tailings will meet the proposed 10E–6A_2/g specific activity limit, and therefore, has not increased the limit. For clarity, the proposals contained in §§ 173.411 and 173.414 have been combined into § 173.411. In § 173.427, reference to IP packagings is followed by a parenthetic reference to § 173.411 to show where the requirements for industrial packagings are found. One commenter requested that the record keeping requirements for IP packagings not apply to IP–1's. RSPA concurs and has revised the final rule accordingly. Some commenters requested that an IP packaging be required to be marked in order to identify that the packaging does meet the appropriate packaging standard. Though RSPA agrees with the commenter's point, RSPA did not propose a marking requirement and, therefore, considers this recommendation outside the scope of the rulemaking. However, RSPA may propose such a requirement in a future rulemaking.

C. International System of Units (SI)

In the NPRM, RSPA proposed that the activity of a package of radioactive materials be described in SI units (i.e., becquerels), consistent with IAEA SS6–85, in lieu of the customary units of curies. Several commenters requested that the use of SI units on shipping papers and labels be required for international shipments only, with domestic shipments using customary units as the standard. The basis of this request appears to be for ease of training of transport workers, emergency responders, and personnel in industry and local governments. It was also noted that most emergency response radiation detection instruments specify readings in customary units only.

U.S. policies and procedures for conversion to the metric system were formalized by the Metric Conversion Act of 1975 (Pub. L. 94–168, 15 U.S.C. 205a). The Act declared that U.S. policy shall be to coordinate and plan the increased use of the metric system. From a safety standpoint, the need for consistency in radioactive materials package identification is critical. All parties potentially having contact with the package must be able to understand the units used in order to establish proper controls. It is recognized that the U.S. conversion to metric units may create special problems since, in order to succeed without jeopardizing safety, the new units must be used, or at least understood, universally.

It is also recognized that the use of SI units for radioactive material has proceeded internationally. IAEA SS6–85 allows the use of both units with SI units controlling. The International Civil Aviation Organization's Technical Instructions and the International Maritime Dangerous Goods Code (IMDG Code) have required the use of the SI units for several years. The fact that international shipments use SI units could give rise to safety concerns if the U.S. fails to accommodate SI units to or from countries using the internationally accepted units.

RSPA recognizes the additional training required by this change; however, the safety benefits exceed the costs and it is necessary to proceed with the change to SI units. However, for domestic shipments, shipping papers and labels may be allowed to contain either SI units or the combination of SI and customary units. In addition, RSPA is delaying mandatory compliance with this requirement until April 1, 1997.

Several commenters were also concerned about the inconsistencies between RSPA and NRC proposed rules with regard to units of measurement. RSPA proposed regulatory requirements using SI units followed by customary units in parenthesis. NRC proposed the reverse order. NRC, in its final rule, agreed with RSPA that SI units must be stated first.

D. Expansion of Radionuclide List and Changes in Radionuclide Limits

The table in § 173.435, which provides A_1 and A_2 values, has been expanded by nearly 100 entries to include all radionuclides that have the potential to be transported. Because there now should be few instances where unlisted radionuclides would be transported, the rules for calculating values for unlisted radionuclides have been simplified. However, the determination of limits for unlisted radionuclides, except in a few cases, is subject to RSPA approval.

IAEA SS6–85 modified the system for determining A_2 and A_2 values. Although this system is based on achieving essentially the same limitations on potential radiological accident hazards as the previous system, the new system has the following advantages:

1. It states more clearly the radiation protection criteria employed;
2. It incorporates the data and conclusions on metabolic pathways provided during the years 1977–1981 by the International Commission on Radiological Protection (ICRP);
3. It includes dosimetric routes through human organs not previously considered; and
4. It harmonizes IAEA SS6–85 with ICRP recommendations on radiological safety in Publications ICRP–26 and ICRP–30.

The effect of the adoption in IAEA SS6–85 of this new system for calculating A_1 and A_2 values, and the subsequent incorporation of the new values in the HMR, is that most current A_1 and A_2 values have been amended. Of the 284 radionuclide entries in § 173.435, A_2 values have been raised in 129 cases and lowered in 95 cases. Of the A_1 values, 144 have been raised and 73 lowered. Several commenters objected to the proposal to lower the A_2 value for molybdenum-99 from 0.8 TBq (20 curies) to 0.5 TBq (13.5 curies).

Commenters stated that shipments of Mo-99\Tc-99m generators to hospitals would increase significantly in order to comply with this lower limit. Instead of being able to ship 0.6 TBq (16 curies) in one generator, manufacturers would have to ship two different generators which would increase their costs and the costs to the hospital. In addition, the commenters contended, these additional shipments would increase the level of radiation exposure for those workers

who handle the generators. The commenters also cited the excellent safety record in transportation of these generators, and requested that a domestic exception be provided to allow these generators, that are DOT Specification 7A Type A packagings, to contain as much as 0.8 TBq 20 curies of molybdenum-99. Upon further review of this proposal and of the data received from the commenters, RSPA has decided to allow a domestic exception for molybdenum-99. A footnote has been added to the § 173.435 Table of A_1 and A_2 values which authorizes, for domestic use only, the use of DOT Specification 7A Type A packagings for molybdenum-99 up to 0.8 TBq (20 curies).

One commenter objected to the lowering of the A_2 values for carbon-14, phosphorus-32, sulfur-35 and iodine-125. The commenter was concerned that these lower values would require Type A packagings for these materials, instead of the excepted packagings that are currently authorized. However, the commenter did not provide sufficient data to support these concerns and, therefore, this commenter's request has not been adopted.

The new IAEA system for calculating A_1 and A_2 values is further described in Appendix I, ''The Q System for the Calculation of A_1 and A_2 Values,'' of IAEA Safety Series No. 7, ''Explanatory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (1985 Edition).'' A copy of this document is available in RSPA's Docket Unit for review by interested parties.

E. Classification of Fissile Material

As a result of the evolution of the fissile material criteria, IAEA recognized that the three fissile classes could be combined and simplified into a single system. The effects of the simplification of the IAEA system now being adopted into the HMR are the:

1. Elimination of the three fissile class designations;
2. Establishment of a single set of criteria for all packages of fissile materials; and
3. Use of the TI as the primary control of accumulations of packages in transportation under nearly all conditions.

F. General Design Requirements for All Packagings

All packagings of radioactive materials, including excepted packages, are required to meet general design requirements prescribed in § 173.410. These packagings must be designed for ease of handling and proper restraint during shipment. They must be free of protuberances, easily decontaminated, capable of withstanding the effects of vibration during transport, and also meet reduced pressure and temperature requirements. Minimum design requirements for excepted packagings will increase the overall integrity of the packages. Further discussion of § 173.410 can be found in the Review-by-Section portion of this preamble.

G. Docket No. HM–181

On December 21, 1990, RSPA published a final rule under Docket No. HM–181 entitled ''Performance-Oriented Packaging Standards: Changes to Classification, Hazard Communication, Packaging and Handling Requirements Based On UN Standards and Agency Initiative'' (55 FR 52402). That final rule comprehensively revised the HMR with respect to hazard communication and packaging standards. In addition, Docket No. HM–181 adopted some of the proposals in the NPRM under docket HM–169A. Those proposals adopted under Docket HM–181 include the reference to the 1985 edition of IAEA Safety Series No. 6, and its 1988 Supplement, and most of the proper shipping names. For additional discussion on the various supplements to IAEA SS6–85 see the discussion of § 171.7 in the Review-By-Section portion of this preamble.

H. Editorial Changes

This final rule makes several editorial changes to the HMR. References to the ''Director, OHMT'' are revised to read ''Associate Administrator, Office of Hazardous Materials Safety''. The term ''radioactive material'' is revised to read ''radioactive materials'' in conjunction with the amendments under Docket No. HM–181. Section 173.411, entitled ''General design requirements'', has been redesignated as § 173.410. Section 173.421–1 through 173.427 are redesignated as §§ 173.422 through 173.428. Corresponding changes have been made to the HMR to other sections which reference the redesignated sections. In the following discussion, section references are to the new section numbers, therefore, RSPA is providing the following redesignation table to assist the reader:

Old section No.	New section No.
§ 173.411	§ 173.410
§ 173.421–1	§ 173.422
§ 173.421–2	§ 173.423
§ 173.422	§ 173.424
§ 173.423	§ 173.425
§ 173.424	§ 173.426
§ 173.425	§ 173.427
§ 173.427	§ 173.428

IV. Review-by-Section

Section 171.7. As proposed, several references to documents have been added and revised in this final rule. It was brought to RSPA's attention that some foreign countries have adopted IAEA SS6–85 or one or more of its supplements (i.e., Supplement 1986, 1988 and the As Amended 1990 edition). Because the changes in these supplements were not substantive in nature, RSPA is allowing the export or importation of radioactive materials in accordance with any of the supplements to the 1985 Edition of IAEA Safety Series No. 6.

Section 171.8. This section is amended by adding definitions for ''General public'' and ''Occupationally exposed hazmat employee''. For additional discussion of these terms and how they relate to radiation protection plans, see section III of this preamble.

Section 171.10. This section is amended to incorporate SI units for radioactive materials. RSPA proposed to add § 173.402 which would have repeated the requirements of § 171.10. Because this would have been repetitive, RSPA is not adopting proposed § 173.402 but is amending § 171.10. Section 171.10 is amended to phase in the SI units for radiological measurements. The HMR uses SI units followed by the customary units in parentheses. In many cases the limits in customary units are extended to 3 significant figures so they represent a functional equivalent to the limits expressed in SI units. The objective of this approach is to achieve consistency with international regulations while allowing U.S. shippers to use the units with which they are most familiar.

Section 171.11. This section is amended to clarify that the provisions of §§ 172.204(c)(4), 173.448(e)(f) and (g)(3) do not apply to limited quantity shipments transported under the provisions of the International Civil Aviation Organization's Technical Instructions for the Transport of Dangerous Goods (ICAO TI).

Section 171.12. This section is editorially revised to reference the correct edition of IAEA Safety Series No. 6 and to clarify that shipments of radioactive materials transported in accordance with IAEA SS6–85 must comply with the emergency response requirements of subpart G of part 172.

Section 172.101. Most of the proposals in the NPRM to amend the

§ 172.101 Table were adopted under Docket No. HM–181. However, several editorial changes are being made to the table to address section number changes (e.g., § 173.421–1 redesignation as § 173.422).

Section 172.203. This section is revised to add references to SI units, replace references to Fissile Class III with ''Fissile material, controlled shipments'' and to require appropriate group notations for LSA and SCO material on shipping papers. In addition, mass information is allowed to replace activity information for uranium fissile radionuclides. For plutonium fissile radionuclides mass information may be included with the activity information on shipping papers. Also, § 172.203(d)(10) is added to require that the phrase ''Exclusive Use Shipment'' be added to shipping descriptions for shipments that are transported under provisions for exclusive use shipments. This statement may appear in any visible location on the shipping paper when the entire shipment is consigned as exclusive use. However, this statement does not relieve a offeror from providing exclusive use shipment controls to the carrier as required by §§ 173.403 and 173.427.

Several commenters to this section objected to requiring the statement ''Fissile Material'' to appear with shipping descriptions for fissile materials because their proper shipping name contains the words ''Radioactive material, fissile, * * *'' RSPA concurs with these commenters and has not adopted this proposal. Another commenter opposed the requirement in § 172.203(d)(1) to list all radionuclides on shipping papers. RSPA recognizes that it is sometimes impractical to identify all radionuclides contained in a package of some radioactive materials. Therefore, in this final rule, RSPA is amending § 172.203(d)(1) to require that the shipping paper identify the most hazardous radionuclides only. These nuclides are determined in accordance with the restriction of activity for A_1 and A_2 values described in § 173.433(f) that specifies, through use of a formula, that those radionuclides that represent 95% of the hazard shall be listed.

Section 172.310. This section is amended to require the trefoil symbol, as specified in new Appendix B to Part 172, be marked on Type B, Type B(U), and Type B(M) packages of radioactive material in a plain and durable fashion. One commenter objected to this requirement on the basis that the package would already display the trefoil on the radioactive material label. However, a label does not meet the requirement of being durable. Therefore, this amendment is adopted as proposed.

Section 172.403. This section is amended to add a reference to SI units. One commenter was concerned over the proposal to allow mass information in place of activity information on labels of fissile material packages. The commenter stated that RSPA should not adopt this proposal because such information would provide insufficient information to radiological emergency response forces in the event of an incident. RSPA agrees with the commenter as it pertains to plutonium radionuclides, but believes that mass information for uranium radionuclides provides sufficient information to emergency responders. Therefore, RSPA is modifying § 172.403 to authorize the substitution of mass information for uranium fissile radionuclides, and the addition of mass information to the activity information for plutonium fissile radionuclides.

Section 172.407. This section is revised by adding paragraph (g) to note where the radioactive trefoil specification is located in the HMR.

Section 172.504. This section is amended by revising the footnote in Table 1 to reference the new section for LSA material and to add reference to SCO.

Section 172.507. This section is editorially revised by correcting section references and terminology (i.e., Class 7 rather than radioactive material).

Sections 172.801–172.807. These sections are added to new subpart I of part 172, to implement a requirement for the establishment of radiation protection programs in accordance with EPA's ''Radiation Protection Guidance to Federal Agencies for Occupational Exposure'' and the IAEA SS6–85. For further discussion of these requirements, see the discussion in section III.A of this preamble.

Appendix B to part 172. Appendix B to Part 172 is added to note size requirements for the trefoil symbol on package markings, labels, and placards. Several commenters noted an error in the proposed size requirements that is corrected in this final rule.

Sections 173.2a and 173.4. These sections are revised to correct section references.

Section 173.403. This section is amended by adding new definitions for: ''Class 7 material,'' ''Surface contaminated object (SCO)'', ''IP packagings'', and, ''Low toxicity alpha emitters''. The definitions for ''Fissile material'' is revised to specify listed radionuclides, and the reference to § 173.455 is removed. The definition of Low specific activity (LSA) material is revised to conform to the IAEA definition. Many commenters requested an expansion of the definition of ''Package-excepted package'' to include § 173.426, articles containing natural uranium and thorium. RSPA agrees with the commenters and is adding that reference.

Several commenters requested that the definition of ''Type A package'' be revised to specify that these packages do not need Competent Authority approval. RSPA agrees, and the definition is so revised. One commenter requested that the definition of ''transport index'' include the commonly used term ''TI''. RSPA has also incorporated this request.

Proposed Section 173.404. This section was proposed to specify the U.S. Competent Authority for the transport of radioactive materials. Because this term is currently defined in § 171.8, thus making proposed § 173.404 repetitive, this proposal has not been adopted.

Section 173.410. This section, entitled ''General design requirements'', was previously found in § 173.411. It is amended as follows:

—A package has to be capable of withstanding the effects of acceleration, vibration or vibration resonance during transport;
—The materials of the packaging and any components must be chemically and physically compatible;
—All valves through which the package contents could escape must be protected; and
—A package intended for air transport has to be designed to withstand reduced temperature and pressure during transport.

Several commenters objected to the proposal to require that excepted packages have a minimum dimension of 10 cm. (4 inches). The commenters stated that IAEA regulations subject only Type A packagings only to the 10 cm. minimum dimension requirement. RSPA agrees with these commenters and has moved the 10 cm. minimum dimension requirement to § 173.412; therefore, excepted packages are not required to have a minimum dimension of 10 cm. (4 inches).

Section 173.411. See section III.B and the discussion of § 173.412 in this preamble for discussion of the changes to this section.

Section 173.412. This section, entitled ''Additional design requirements for Type A packages,'' is amended to permit all packages containing liquids to use a double containment system. This eliminates the previous small package prohibition of this practice as well as requiring that expansion of liquids during temperature changes be

considered during design. This section is amended to include a closure requirement on a containment system that is a separate unit of the packaging. One commenter requested that the phrase ''significant increase'' be revised to read ''20% increase'', which would be in conformance with IAEA. RSPA believes that the term ''significant'' is necessary to handle the different packaging parameters, and therefore, is not adopting this commenter's request.

Section 173.413. This section is editorially revised to correct section references and terminology.

Section 173.415. This section, ''Authorized Type A packages'', is amended to eliminate the reference to DOT Specification 55 packaging, which has not been authorized since July 1, 1985. This section is also amended to permit the use of Type A packagings that meet the NRC fissile material packaging requirements.

Section 173.416. This section, ''Authorized Type B packages,'' is amended to eliminate the reference to the DOT Specification 55 packaging, and eliminate the use of DOT Specification 55 packaging as an inner container for DOT Specification 20WC and 21WC overpacks.

Section 173.417. This section, ''Authorized packages—fissile materials,'' is amended to eliminate references to different fissile classes and to remove a direct reference to authorized packaging for 500 grams of Uranium-235 and 320 grams of plutonium. Section 173.417(a)(8) and (b)(5) specify the authorized packagings for Type A and Type B, respectively, quantities of uranium hexafluoride (UF_6). Section 173.417(b)(5)(iii) limits the amount of uranium hexafluoride in a package to the amount specified in ''Table 6—Authorized Quantities Of Uranium Hexafluoride (UF_6).'' In Table 6, however, only DOT specifications 20PF–1 and 20PF–2 are authorized to contain a Type B quantity of uranium hexafluoride. Therefore, § 173.417(b)(5) is revised to authorize only the DOT specifications 20PF–1 and 20PF–2 for the transportation of Type B quantities of uranium hexafluoride. In addition, because their use is no longer allowed, the Specification DOT 21PF–1 overpack has been removed from § 173.417(a)(8)(ii).

Sections 173.418–173.420. These sections are revised to correct section references and terminology. In addition, this section is revised, consistent with the changes in § 173.423, to note that limited quantities of radioactive material that meet the definition of a hazardous substance or hazardous waste must comply with the shipping paper requirements of the HMR.

Section 173.421. This section, ''Excepted packages for limited quantities of radioactive material,'' is amended to require compliance with the design requirements of § 173.410.

Section 173.422. The proposal in this section, ''Additional requirements for excepted packages,'' to incorporate new proper shipping names and new UN identification numbers for excepted packages, was adopted under Docket HM–181. Therefore, no changes are made in this final rule.

Section 173.423. This section is revised to correct section references and terminology. This section is also revised based on changes from Docket HM–181 and to correct terminology. Since a material that meets the definition of Class 7 it cannot, by definition, meet the definition of Class 9, reference to Class 9 are removed and appropriate changes have been made to § 173.421 (i.e., shipping papers are required). In addition, RSPA believes that specific references to Combustible liquids are no longer needed with the changes to § 173.421, therefore, the provisions previously found in paragraph (b) have been removed.

Section 173.424. The NPRM proposed amending this section, ''Excepted packages for instruments and articles,'' to require that instruments and articles be marked with the word ''radioactive.'' Several commenters objected to this proposal. The commenters indicated that devices containing radioactive materials in small quantities require approval by the NRC, who does not require the ''Radioactive'' marking. They expressed concern that the marking may cause a disproportionate public alarm for a very small quantity of radioactive material. Commenters from the lighting industry also were concerned that the ''Radioactive'' marking may discourage the use of energy efficient lighting products. Upon review of the proposed requirement, and contrasting the cost to the manufacturer and the possible effect on NRC exempt-distribution licensees versus the increase in safety that the marking may provide, RSPA is not to adopting this proposal. RSPA notes, however, that such instruments and articles must be so marked if transported in accordance with the ICAO Technical Instructions, IAEA Safety Series No. 6, or the IMDG Code.

Section 173.425. As proposed, this section, ''Table of activity limits—excepted quantities and articles,'' would have removed the direct reference to tritiated water. Several commenters requested that these limits be retained for domestic use only. Because of the relatively low hazards associated with tritiated water, RSPA concurs with these commenters and has not removed these limits.

Sections 173.426–173.431. See the ''Background'' section of the preamble for discussion of the changes to these sections.

Section 173.433. This section, ''Requirements for determination of A_1 and A_2 values for radionuclides,'' is completely amended to incorporate a less complex method for calculating the A_1 and A_2 values.

Section 173.434. This section is revised to add references to SI units.

Section 173.435. This section, ''Table for A_1 and A_2 values for radionuclides,'' is amended to incorporate new A_1 and A_2 values as specified in the IAEA regulations.

Section 173.441. Several commenters to this section, ''Radiation level limitations,'' requested that the limits specified be applied only to the ''accessible'' surface of the package. RSPA believes that this issue warrants further public discussion and, therefore, it is beyond the scope of this rulemaking. RSPA will consider proposing a change consistent with this request in future rulemaking.

Section 173.442–173.446. These sections are revised to correct section references and terminology.

Section 173.447. This section, ''Storage incident to transportation—general requirements,'' is amended to delete references to fissile classes. Additionally, two commenters requested that this section be eliminated, based on the idea that if a larger number of packages were permitted to be stored together, rather than segregated by the sum of the transport indices, the packages would shield each other and thus reduce the total potential exposure. RSPA believes that this issue is beyond the scope of this rulemaking.

Section 173.448. This section, ''General transportation requirements,'' is amended to delete references to fissile classes.

Section 173.451. See the ''Background'' section of the preamble for a discussion of the changes to this section.

Section 173.453. This section, ''Fissile materials—exceptions,'' is amended by deleting the exception for thermal reactor irradiated uranium and thorium or uranium with not more than 0.72% fissile material. One commenter pointed out that the higher limit of 800 grams of fissile mass should apply to uranium-235 only. RSPA concurs and has modified this section accordingly.

Section 173.455. This section, ''Classification of fissile materials packages,'' is deleted entirely because of the elimination of fissile classes.

Section 173.457. This section, ''Transportation of fissile material-controlled shipment—requirements,'' redefines fissile class III shipments in terms of a ''fissile material, controlled shipment.''

Section 173.459. This section, ''Mixing of fissile materials packages,'' is amended to delete references to fissile classes and to express shipment controls in terms of fissile material, controlled shipments.

Section 173.461. This section, ''Demonstration of compliance with tests,'' is amended to clarify that surrogate materials may be used in packagings to demonstrate compliance with the performance requirements for the package.

Sections 173.462–173.467. These sections are revised to correct section references and terminology.

Section 173.468. This section, ''Test for LSA-III material'', is added to specify a leaching test to examine the solid nature of the material for qualification of the material as LSA-III.

One commenter asked that the section be clarified to state whether immersion tests must be conducted on full-scale or on represented small scale samples. RSPA never intended to disallow the provisions of § 173.461, which allows scale model testing, for the tests required in § 173.468. The second sentence of proposed § 173.468(a), which stated that ''[e]ach solid specimen to be tested must be representative of the actual solid LSA-III material that will be transported'', might have been misinterpreted. To clarify that a representative scale model sample may be used as the test specimen, RSPA is not adopting that sentence.

Section 173.469. This section, ''Tests for special form Class 7 (radioactive) material,'' is amended to add an alternative method to qualify special form radioactive material under the specific impact and temperature tests prescribed in the specified standard of the International Organization for Standardization (ISO). One commenter stated that the ISO standard allowed leakage and leaching tests that are not as sensitive as the tests prescribed in § 173.469(a)(4) and (b) and, therefore, should not be adopted. RSPA agrees that some of the ISO test methods are not as sensitive for some source designs as those prescribed in the regulations. However, ISO's test method has a lower acceptance criteria which compensates for the less sensitive test methods. Therefore, RSPA is not adopting this commenters request.

Sections 173.471–173.473. These sections are amended to require that applicants for Competent Authority Approvals of Type B packaging designs, including those requesting to become registered users, submit a description to RSPA of the quality assurance program in effect during the design, manufacture, testing, documentation, use, maintenance, and inspection of the package as required by IAEA. These sections are also amended to require that submissions be made in triplicate and 90 days in advance of the shipment. It should be noted that IAEA regulations require that the serial number be marked on Type B packagings. Though not required by RSPA in this final rule, packages shipped in accordance with the IAEA regulations will be required to be marked with the serial number of the packaging.

Sections 173.474–173.475. These section are not amended but are reprinted for ease of understanding.

Section 173.476. This section, ''Approval of special form Class 7 (radioactive) materials,'' is amended to require that the original applicant provide evidence of the quality assurance program in effect during the design, manufacture, testing, documentation, use, maintenance, and inspection of the material as required by IAEA. In addition, this section is amended to require that submissions be made in triplicate and 90 days in advance of the shipment.

Section 173.477. This section, ''Approval for export shipments,'' is amended to delete references to fissile classes. Additionally, a new subparagraph addresses the contents of an application for shipment approval under special arrangement.

Section 173.478. This section, ''Notification to competent authorities for export shipments,'' is amended to delete references to fissile classes and requires additional information to be submitted to other national competent authorities for special arrangement shipments. Specifically, notification of a special arrangement shipment is required to include the name of the radionuclide, a description of the physical and chemical form, and the activity of the material.

Section 174.705. This section, entitled ''Radiation Protection Program,'' is added to prohibit the transport of radioactive material by a rail carrier that does not maintain a radiation protection program for each of its occupationally exposed hazmat employees as required by subpart I of part 172. For further discussion of these requirements, see section III.A of this preamble.

Section 175.704. This section has been added, which incorporates proposed 10 CFR 71.88(c), as proposed by NRC. This new section imposes loading and storage restrictions on packages of plutonium. Because these requirements are more appropriate to 49 CFR part 175 than in 10 CFR part 71, RSPA is adopting them in this section.

Section 175.706. This section, entitled ''Radiation Protection Program,'' is added to prohibit the transport of radioactive material by an air carrier that does not maintain a radiation protection program for each of its occupationally exposed hazmat employees as required by subpart I of part 172. For further discussion of these requirements, see section III.A of this preamble.

Section 176.703. This section, entitled ''Radiation Protection Program,'' is added to prohibit the transport of radioactive material by a vessel operator that does not maintain a radiation protection program for each of its occupationally exposed hazmat employees as required by subpart I of part 172. For further discussion of these requirements, see section III.A of this preamble.

Section 177.827. This section, entitled ''Radiation Protection Program,'' is added to prohibit the transport of radioactive material by a motor carrier that does not maintain a radiation protection program for each of its occupationally exposed hazmat employees as required by subpart I of part 172. For further discussion of these requirements, see section III.A of this preamble.

In addition to the foregoing section changes, other sections contained in parts 174 through part 178, involving radioactive material transportation, have been updated to for consistency with changes in parts 171 through part 173. Some of these changes include the addition of metric and SI units and changes in regulatory references. The following is list of those sections:

Part 174	Part 175	Part 176	Part 177	Part 178
174.700	175.700	176.700	177.842	178.350

Part 174	Part 175	Part 176	Part 177	Part 178
174.715	175.702	176.704	177.843	.....
174.750	175.703	176.708	177.861	.....
	.....	176.715	.....	.....

V. Regulatory Analyses and Notices

Executive Order 12866 and DOT Regulatory Policies and Procedures

This final rule is not considered a significant regulatory action under section 3(f) of Executive Order 12866 and was not reviewed by the Office of Management and Budget. The rule is not considered significant under the regulatory policies and procedures of the Department of Transportation (44 FR 11034). A regulatory evaluation is available for review in the docket.

Executive Order 12612

This final rule has been analyzed in accordance with the principles and criteria contained in Executive Order 12612 (''Federalism''). The Federal hazardous materials transportation law (49 USC 5101–5127) contains an express preemption provision that preempts State, local, and Indian tribe requirements on certain covered subjects. Covered subjects are:

(i) The designation, description, and classification of hazardous materials;

(ii) The packing, repacking, handling, labeling, marking, and placarding of hazardous materials;

(iii) The preparation, execution, and use of shipping documents pertaining to hazardous materials and requirements respecting the number, content, and placement of such documents;

(iv) The written notification, recording, and reporting of the unintentional release in transportation of hazardous materials; or

(v) The design, manufacturing, fabrication, marking, maintenance, reconditioning, repairing, or testing of a package or container which is represented, marked, certified, or sold as qualified for use in the transportation of hazardous materials.

This final rule concerns the packaging and classification of radioactive materials. This final rule preempts State, local, or Indian tribe requirements in accordance with the standards set forth above. The Federal statute provides that if DOT issues a regulation concerning any of the covered subjects after November 16, 1990, DOT must determine and publish in the **Federal Register** the effective date of Federal preemption (49 USC 5125(b)(2)). That effective date may not be earlier than the 90th day following the date of issuance of the final rule and not later than two years after the date of issuance. RSPA has determined that the effective date of Federal preemption for these requirements is April 1, 1996. Thus RSPA lacks discretion in this area, and preparation of a federalism assessment is not warranted.

Executive Order 12778

Any interested person may petition RSPA's Administrator for reconsideration of this final rule within 30 days of publication of this rule in the **Federal Register**, in accordance with the procedures set forth at 49 CFR 106.35. Neither the filing of a petition for reconsideration nor any other administrative proceeding is required before the filing of a suit in court for review of this rule.

Regulatory Flexibility Act

I certify that this final rule will not have a significant economic impact on a substantial number of small entities. This rule applies to shippers and carriers of radioactive materials, some of whom are small entities.

Paperwork Reduction Act

The information collection requirements contained in this rule have been approved by the Office of Management and Budget under the provisions of the Paperwork Reduction Act of 1980 (44 U.S.C. 3504(h)) and assigned control number 2137–0510.

Regulation Identifier Number (RIN)

A regulation identifier number (RIN) is assigned to each regulatory action listed in the Unified Agenda of Federal Regulations. The Regulatory Information Service Center publishes the Unified Agenda in April and October of each year. The RIN number contained in the heading of this document can be used to cross-reference this action with the Unified Agenda.

List of Subjects

49 CFR Part 171

Exports, Hazardous materials transportation, Hazardous waste, Imports, Incorporation by reference, Reporting and recordkeeping requirements.

49 CFR Part 172

Hazardous materials transportation, Hazardous waste, Labeling, Packaging and containers, Reporting and recordkeeping requirements.

49 CFR Part 173

Hazardous materials transportation, Incorporation by reference, Packaging and containers, Radioactive materials, Reporting and recordkeeping requirements, Uranium.

49 CFR Part 174

Hazardous materials transportation, Radioactive materials, Railroad safety.

49 CFR Part 175

Air carriers, Hazardous materials transportation, Radioactive materials, Reporting and recordkeeping requirements.

49 CFR Part 176

Hazardous materials transportation, Maritime carriers, Radioactive materials, Reporting and recordkeeping requirements.

49 CFR Part 177

Hazardous materials transportation, Motor carriers, Radioactive materials, Reporting and recordkeeping requirements.

49 CFR Part 178

Hazardous materials transportation, Packaging and containers, Reporting and recordkeeping requirements.

In consideration of the foregoing, 49 CFR parts 171, 172, 173, 174, 175, 176, 177 and 178 are amended as follows:

PART 171—GENERAL INFORMATION, REGULATIONS, AND DEFINITIONS

1. The authority citation for part 171 continues to read as follows:

Authority: 49 U.S.C. 5101–5127;

49 CFR part 1.53.

§ 171.7 [Amended]

2. In § 171.7, the Table of material incorporated by reference, in paragraph (a)(3), is amended by removing the entry for ''USAEC, ORO–651,'' under the Department of Energy (USDOE), revising the entry for ''IAEA, Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6,'' under the *International Atomic Energy Agency (IAEA)* and by adding an entry for ''ORO–651'' under the Department of Energy and three new entries following

the exiting entries, under the *International Organization for Standardization,* to read as follows:

Source and name of material	49 CFR reference
Department of Energy (USDOE)	
* * * * * * *	
ORO–651 - Uranium Hexafluoride; A Manual of Good Practices, Revision 6, 1991 edition.	173.417
* * * * * * *	
International Atomic Energy Agency (IAEA),	
* * * * * * *	
IAEA, Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1985 Edition (As Amended 1990); Including 1985 Edition (Supplemented 1986 and 1988)	171.12
* * * * * * *	
International Organization for Standardization (ISO)	
* * * * * * *	
ISO/TR 4826–1979(E) - Sealed radioactive sources—Leak test methods	173.469
ISO 2919–1980(E) - Sealed radioactive sources—Classification	173.469
ISO 1496–3–1995(E) - Series 1 Freight Containers—Specification and Testing—Part 3: Tank Containers for Liquids, Gases and Pressurized Dry Bulk	173.411
* * * * * * *	

* * * * *

3. In § 171.8, the following definitions are added in appropriate alphabetical order to read as follows:

§ 171.8 Definitions and abbreviations.

* * * * *

General public means, for purposes of subpart I of part 172, and subpart I of part 173 of this subchapter, any person other than an occupationally exposed hazmat employee.

* * * * *

Occupationally exposed hazmat employee means a hazmat employee whose duties involve exposure to ionizing radiation.

* * * * *

4. In § 171.10(c)(2), the ''Table of Conversion Factors For SI Units'' is amended by adding the following entries in appropriate alphabetical order and the note following the table is revised to read as follows:

§ 171.10 Units of measure.

* * * * *

(c) * * *

(2) * * *

TABLE OF CONVERSION FACTORS FOR SI UNITS

Measurement	SI to US standard	US standard to SI
Activity	1 TBq=27 Ci	1 Ci=0.037 TBq.
* * * * *		
Radiation level	1 Sv/hr=100 rem/hr	1 rem/hr=0.01 Sv/hr

Abbreviation for units of measure are as follows:
Unit of measure and abbreviation:
(SI): millimeter, mm; centimeter, cm; meter, m; gram, g; kilogram, kg; kiloPascal, kPa; liter, L; milliliter, ml; cubic meter, m^3; Terabecquerel, TBq; Gigabecquerel, GBq; millisievert, mSv;
(U.S.): Inch, in; foot, ft; ounce, oz; pound, lb; pounds per square inch, psi; gallon, gal; cubic feet, ft^3; Curie, Ci; millicurie, mCi; millirem, mrem.

5. Section 171.11(d)(6)(iii) is revised to read as follows:

§ 171.11 Use of ICAO Technical Instructions.

* * * * *

(d) * * *

(6) * * *

(iii) Except for limited quantities of Class 7 (radioactive) material, the provisions of §§ 172.204(c)(4), 173.448(e), (f) and (g)(3) of this subchapter apply.

* * * * *

§ 171.11 [Amended]

6. In addition, in § 171.11(d)(6)(iv), remove the words ''§ 173.422 or § 173.424'' and add, in their place, the words ''§ 173.424 or § 173.426''.

7. In § 171.12, the heading and introductory text of paragraph (d) and paragraph (d)(4) are revised, paragraph (d)(5) is amended by removing the period and adding ''; and'' in its place, and paragraph (d)(6) is added to read as follows:

§ 171.12 Import and export shipments.

* * * * *

(d) *Use of IAEA regulations for Class 7 (radioactive) materials.* Class 7 (radioactive) materials being imported into, or exported from, the United States, or passing through the United States in the course of being shipped between places outside the United States, may be offered and accepted for transportation when packaged, marked, labeled, and otherwise prepared for shipment in accordance with IAEA ''Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6,'' if:

* * * * *

(4) The country of origin for the shipment has adopted the IAEA ''Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6'';

* * * * *

(6) Shipments comply with the requirements for emergency response information prescribed in Subpart G of Part 172 of this subchapter.

PART 172—HAZARDOUS MATERIALS TABLE, SPECIAL PROVISIONS, HAZARDOUS MATERIALS COMMUNICATIONS, EMERGENCY RESPONSE INFORMATION, AND TRAINING REQUIREMENTS

8. The authority citation for Part 172 continues to read as follows:

Authority: 49 U.S.C. 5101–5127; 49 CFR part 1.53.

9. The following entries in the § 172.101 Hazardous Materials Table are removed, added in alphabetical order or revised to read as follows:

§ 172.101 Purpose and use of hazardous materials table.

* * * * *

§ 172.101 HAZARDOUS MATERIALS TABLE

Symbols	(1)Hazardous materials descriptions and proper shipping names	(2)Hazard class or Division	(3)Identification Numbers	Packing group	Label(s) required (if not excepted)	Special provisions	(8) Packaging authorizations (§ 173.***)			(9) Quantity limitations		(10) Vessel stowage requirements	
							Exceptions	Nonbulk packaging	Bulk packaging	Passenger aircraft or rail-car	Cargo aircraft only	Vessel stowage	Other stowage provisions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8A)	(8B)	(8C)	(9A)	(9B)	(10A)	(10B)
	.....												
	[Remove]												
	Radioactive material, excepted package-empty packaging.	7	UN2910	.....	EMPTY	.....	427 ...	427 ...	427 ...	.....	.....	A	
	*	*	*		*		*		*			*	
	Radioactive material, low specific activity, n.o.s. *or* Radioactive material, LSA, n.o.s..												
	[Add]												
	*	*	*		*		*		*			*	
	Radioactive material, excepted package-empty package *or* empty packaging.	7	UN2910	.....	EMPTY	.....	421, 428.	421, 428.	421, 428.	.....	.....	A	
	*	*	*		*		*		*			*	
	Radioactive material, low specific activity *or* Radioactive material, LSA, n.o.s.	7	UN2912	.....	RADIOACTIVE.	.....	421, 428.	427 ...	427 ...	.....	.....	A	.....
	*	*	*		*		*		*			*	
	Radioactive material, surface contaminated object *or* Radioactive material, SCO.	7	UN2913	.....	RADIOACTIVE.	421, 424, 426	427 ...	427 ...	.....	.....	A		
	*	*	*		*		*		*			*	
	[Revise]												
	*	*	*		*		*		*			*	
	Radioactive material, excepted package-articles manufactured from natural *or* depleted uranium or natural thorium.	7	UN2910	.....	None	.....	422, 426.	422, 426.	422, 426.	.....	.....	A	
	*	*	*		*		*		*			*	
	Radioactive material, excepted package-instruments *or* articles.	7	UN2910	.....	None	.....	422, 424.	422, 424.	422, 424.	.....	.....	A	

§ 172.101 HAZARDOUS MATERIALS TABLE—Continued

Symbols	(1)Hazardous materials descriptions and proper shipping names	(2)Hazard class or Division	(3)Identification Numbers	Packing group	Label(s) required (if not excepted)	Special provisions	(8) Packaging authorizations (§ 173.***)			(9) Quantity limitations		(10) Vessel stowage requirements	
							Exceptions	Nonbulk packaging	Bulk packaging	Passenger aircraft or railcar	Cargo aircraft only	Vessel stowage	Other stowage provisions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8A)	(8B)	(8C)	(9A)	(9B)	(10A)	(10B)
	Radioactive material, excepted package-limited quantity of material.	7	UN2910		None		421, 422.	421, 422.	421, 422.			A	
	*	*	*		*		*		*			*	
	Radioactive material, n.o.s..	7	UN2982		RADIOACTIVE.		421, 428.	415, 416.	415, 416.			A	40, 95
	Radioactive material, special form, n.o.s..	7	UN2974		RADIOACTIVE.		421, 424.	415, 416.	415, 416.			A	
	*	*	*		*		*		*			*	

§ 172.101 [Amended]

10. In addition, in § 172.101, in the Hazardous Materials Table, for the entry ''Uranium hexafluoride, *fissile excepted or non-fissile*'' the column (8A) section reference ''421–2'' is revised to read ''423''.

11. In § 172.203, paragraphs (d)(1), (d)(4), and (d)(7) are revised and paragraphs (d)(10) and (d)(11) are added to read as follows:

§ 172.203 Additional description requirements.

* * * * *

(d) * * *

(1) The name of each radionuclide in the Class 7 (radioactive) material that is listed in § 173.435 of this subchapter. For mixtures of radionuclides, the radionuclides that must be shown must be determined in accordance with § 173.433(f) of this subchapter.

* * * * *

(4) The activity contained in each package of the shipment in terms of the appropriate SI units (e.g. Becquerel, Terabecquerel, etc.) or in terms of the appropriate SI units followed by the customary units (e.g. Curies, millicuries, etc.). Alternatively, for domestic transportation, the activity in a package of Class 7 (radioactive) materials may be described solely in terms of curies until April 1, 1997. Abbreviations are authorized. Except for plutonium-238, plutonium-239, and plutonium-241, the weight in grams or kilograms of fissile radionuclides may be inserted instead of activity units. For plutonium-238, plutonium-239, and plutonium-241 the weight in grams or kilograms of fissile radionuclides may be inserted in addition to the activity units. For the shipment of a package containing a highway route controlled quantity of Class 7 (radioactive) materials (see § 173.403 of this subchapter) the words ''Highway route controlled quantity'' must be entered in association with the basic description.

* * * * *

(7) For a shipment of fissile Class 7 (radioactive) materials:

(i) The words ''Fissile Excepted'' if the package is excepted pursuant to § 173.453 of this subchapter;

(ii) For a fissile material, controlled shipment, the additional notation: ''Warning—Fissile material, controlled shipment. Do not load more than * * * packages per vehicle.'' (Asterisks to be replaced by appropriate number.) ''In loading and storage areas, keep at least 6 meters (20 feet) from other packages bearing radioactive labels''; and

(iii) If a fissile material, controlled shipment is to be transported by water, the supplementary notation must also include the following statement: ''For shipment by water, only one fissile material, controlled shipment is permitted in each hold.''

* * * * *

(10) For a shipment required by this subchapter to be consigned as exclusive use:

(i) An indication that the shipment is consigned as exclusive use; or

(ii) If all the descriptions on the shipping paper are consigned as exclusive use, then the statement ''Exclusive Use Shipment'' may be entered only once on the shipping paper in a clearly visible location.

(11) For a shipment of low specific activity material or surface contaminated objects, the appropriate group notation of LSA–I, LSA–II, LSA–III, SCO–I, or SCO–II.

* * * * *

12. Section 172.310 is revised to read as follows:

§ 172.310 Class 7 (radioactive) materials.

In addition to any other markings required by this subpart, each package containing Class 7 (radioactive) materials must be marked as follows:

(a) Each package with a gross mass greater than 50 kilograms (110 pounds) must have the its gross mass marked on the outside of the package.

(b) packaging must be marked on the outside of the package, in letters at least 13 mm (0.5 inch) high, with the words ''TYPE A'' or ''TYPE B'' as appropriate. A packaging which does not conform to Type A or Type B requirements may not be so marked.

(c) Each Type B, Type B(U) or Type B(M) packaging must be marked on the outside of the package with a radiation symbol that conforms to the requirements of Appendix B to Part 172.

(d) Each package destined for export shipment must also be marked ''USA'' in conjunction with the specification marking, or other package certificate identification. (See §§ 173.471, 173.472, and 173.473 of this subchapter).

13. In § 172.403, the section heading, and paragraphs (b), (c), (d), (g)(1) and (g)(2) are revised to read as follows:

§ 172.403 Class 7 (radioactive) material.

* * * * *

(b) The proper label to affix to a package of Class 7 (radioactive) material is based on the radiation level at the surface of the package and the transport index. The proper category of label must be determined in accordance with paragraph (c) of this section. The label to be applied must be the highest category required for any of the two determining conditions for the package. RADIOACTIVE WHITE–I is the lowest category and RADIOACTIVE YELLOW–III is the highest. For example, a package with a transport index of 0.8 and a maximum surface radiation level of 0.6 millisievert (60 millirems) per hour must bear a RADIOACTIVE YELLOW–III label.

(c) Category of label to be applied to Class 7 (radioactive) materials packages:

Transport index	Maximum radiation level at any point on the external surface	Label category[1]
0[2]	Less than or equal to 0.005 mSv/h (0.5 mrem/h).	WHITE–I.
More than 0 but not more than 1	Greater than 0.005 mSv/h (0.5 mrem/h) but less than or equal to 0.5 mSv/h (50 mrem).	YELLOW–II.
More than 1 but not more than 10	Greater than 0.05 mSv/h (50 mrem) but less than or equal to 2 mSv/h (200 mrem/h).	YELLOW–III.
More than 10	Greater than 2 mSv/h (200 mrem/h) but less than or equal to 10 mSv/h (1,000 mrem/h).	YELLOW–III (Must be shipped under exclusive use provisions; see 173.441(b) of this subchapter).

[1] Any package containing a ''highway route controlled quantity'' (§ 173.403 of this subchapter) must be labelled as RADIOACTIVE YELLOW–III.
[2] If the measured TI is not greater than 0.05, the value may be considered to be zero.

(d) *EMPTY* label. See § 173.428(d) of this subchapter for EMPTY labeling requirements.

* * * * *

(g) * * *

(1) *Contents.* The name of the radionuclides as taken from the listing of radionuclides in § 173.435 of this subchapter (symbols which conform to established radiation protection terminology are authorized, i.e., ^{99}Mo, ^{60}Co, etc.). For mixtures of radionuclides, with consideration of space available on the label, the radionuclides that must be shown must be determined in accordance with § 173.433(f) of this subchapter.

(2) *Activity.* Activity units must be expressed in appropriate SI units (e.g., Becquerels (Bq), Terabecquerels (TBq), etc.) or in both appropriate SI units and appropriate customary units (Curies (Ci), milliCuries (mCi), microcuries (uCi), etc.). Alternatively, the activity may be expressed solely in terms of curies until April 1, 1997. Abbreviations are authorized. Except for plutonium-238, plutonium-239, and plutonium-241, the weight in grams or kilograms of fissile radionuclides may be inserted instead of activity units. For plutonium-238, plutonium-239, and plutonium-241, the weight in grams or kilograms of fissile radionuclides may be inserted in addition to the activity units.

* * * * *

14. In § 172.407, paragraph (g) is added to read as follows:

§ 172.407 Label specifications.

* * * * *

(g) *Trefoil symbol.* The trefoil symbol on the RADIOACTIVE WHITE–I, RADIOACTIVE YELLOW–II, and RADIOACTIVE YELLOW–III labels must meet the appropriate specifications in Appendix B of this part.

§ 172.504 [Amended]

15. In § 172.504, in Table 1 of paragraph (e), footnote one is revised to read as follows:

[1] RADIOACTIVE placard also required for exclusive use shipments of low specific activity material and surface contaminated objects transported in accordance with § 173.427(b)(3) or (c) of this subchapter.

16. In § 172.507, paragraph (a) is revised to read as follows:

§ 172.507 Special placarding provisions: Highway.

(a) Each motor vehicle used to transport a package of highway route controlled quantity Class 7 (radioactive) materials (see § 173.403 of this subchapter) must have the required RADIOACTIVE warning placard placed on a square background as described in § 172.527.

* * * * *

17. In § 172.519, paragraph (g) is added to read as follows:

§ 172.519 General specifications for placards.

* * * * *

(g) *Trefoil symbol.* The trefoil symbol on the RADIOACTIVE placard must meet the appropriate specification in Appendix B of this part.

18. A new subpart I is added to part 172 to read as follows:

Subpart I—Radiation Protection Program

Subpart I—Radiation Protection Program

§ 172.801 Applicability of the radiation protection program.

(a) *Scope.* This subpart prescribes requirements for developing and maintaining a radiation protection program.

(b) *Applicability.* This subpart applies to persons who offer for transportation, accept for transportation, or transports Class 7 (radioactive) materials.

§ 172.803 Radiation protection program.

Each person who offers for transportation, accepts for transportation, or transports Class 7 (radioactive) materials must develop, implement and maintain a written radiation protection program in accordance with the following:

(a) Radiation exposures must be kept as low as reasonably achievable (ALARA), with economic and social factors being taken into account.

(b) Radiation exposures must be control such that:

(1) An occupationally exposed hazmat employee's annual effective dose equivalent for occupational radiation exposure will not exceed 12.5 mSv (1.25 rem) in any 3 month period or 50 mSv (5 rem) in any 12 month period. For workers under the age of eighteen, the radiation dose will not exceed 1.250

mSv (0.125 rem) in any 3 month period or 5.0 mSv (0.5 rem) in any 12 month period;

(2) Radiation exposures to members of the general public must be less than 0.02 mSv (2 mrem) per hour. This level will be measured as if an individual were present for an hour in any area where the general public could be exposed to radiation during the course of transportation, except that, if there is an occurrence where the dose to a member of the general public equals or exceeds 0.02 mSv (2 mrem) in one hour, the program must provide limits that will prevent an individual from receiving cumulative doses totaling 1.0 mSv (100 mrem) in any week or 5.0 mSv (500 mrem) in any twelve-month period;

(3) The radiation dose to an embryo-fetus in a pregnant female occupationally exposed hazmat employee, who has declared her pregnancy to her employer, must not exceed 5.0 mSv (500 mrem) during the pregnancy. This limit is to be achieved by limiting the radiation dose of the declared pregnant worker to not more than 5.0 mSv (500 mrem) during the nine months and not greater than 0.5 mSv (50 mrem) in any one month; and

(4) The radiation doses received by occupationally exposed hazmat employees must be monitored by radiation dosimetry devices.

(c) The Environmental Protection Agency report entitled ''Radiation Protection Guidance to Federal Agencies for Occupational Exposure (January 1987)''. This document is available from the U.S. Environmental Protection Agency, Washington, DC 20460.

(d) *Exceptions.* (1) The requirements of this subpart do not apply to:

(i) Persons who offer for transportation or transport less than 200 TI of packages in a 12-month period; or

(ii) Those persons whose operations will not result in a hazmat employee receiving an exposure of 5 mSv (500 mrem) or more per year. This evaluation must consider the hazmat employers Class 7 (radioactive) materials transportation activities for a period of at least 12 months. An evaluation must be conducted by a person experienced with radiation protection programs and transportation regulations and programs. The evaluator's competency may be evidenced by being certified by the American Board of Health Physics, or by a letter of recommendation from any Regional Administrator of the Nuclear Regulatory Commission or from a State Radiation Official listed in the most current issue of the ''Directory of Personnel Responsible For Radiological Health Programs'' published annually by the Conference of Radiation Control Program Directors, Frankfort, KY.

(2) The requirements of this subpart may be satisfied by any radiation protection program that has been approved by an appropriate federal or state agency.

(e) *Guidance.* Each hazmat employer should review and follow the guidance provided in the following documents when establishing and maintaining their radiation protection program:

(i) National Council on Radiation Protection and Measurements (NCRP) Report No. 59, ''Operational Radiation Safety Program (1978)''. The guidance in this report should be tailored to the practical needs and operations of the hazmat employer and their occupationally exposed hazmat employees.

(ii) NCRP Report No. 116, ''Limitation of Exposure to Ionizing Radiation (1993)''.

(2) The reports referenced in paragraph (e)(1) of this section are available from NCRP Publications, 7910 Woodmont Avenue, Bethesda, MD 20814.

§ 172.805 Recordkeeping and notifications.

(a) A hazmat employer must document their radiation protection program and maintain written records of the radiation protection program activities, including dosimetry records, described in this subpart. These records must be made available to the Associate Administrator for Hazardous Materials Safety or other authorized officials in written form within seven days of a written request.

(b) A hazmat employer must keep a record of the radiation dose that each hazmat employee has received and provide it to the employee in reasonable time following a request during employment and no more than three months after end of employment.

(c) Each hazmat employer must notify the Associate Administrator for Hazardous Materials Safety, in writing, if a hazmat employee receives a dose exceeding 12.5 mSv (1250 mrem) in any calendar quarter or 50 mSv (5,000 mrem) in one year, or if a member of the general public is likely to receive a dose exceeding 5 mSv (500 mrem) in one year as a result of the hazmat employer's transportation activities. Such a notification must be made as soon as practicable following awareness of the occurrence.

(d) If an offeror or carrier of Class 7 (radioactive) materials is not required to establish a radiation protection program, they must develop and keep records which demonstrate why a program is not required (i.e., either the total TI of packages transported in any 12 month period is less than 200, or that the current Class 7 (radioactive) materials transport activities are the same as the activities that were reviewed by a competent radiation protection specialist whose evaluation demonstrated that no worker will receive a dose exceeding 5 mSv (500 mrem) in one year).

§ 172.807 Transitional provisions.

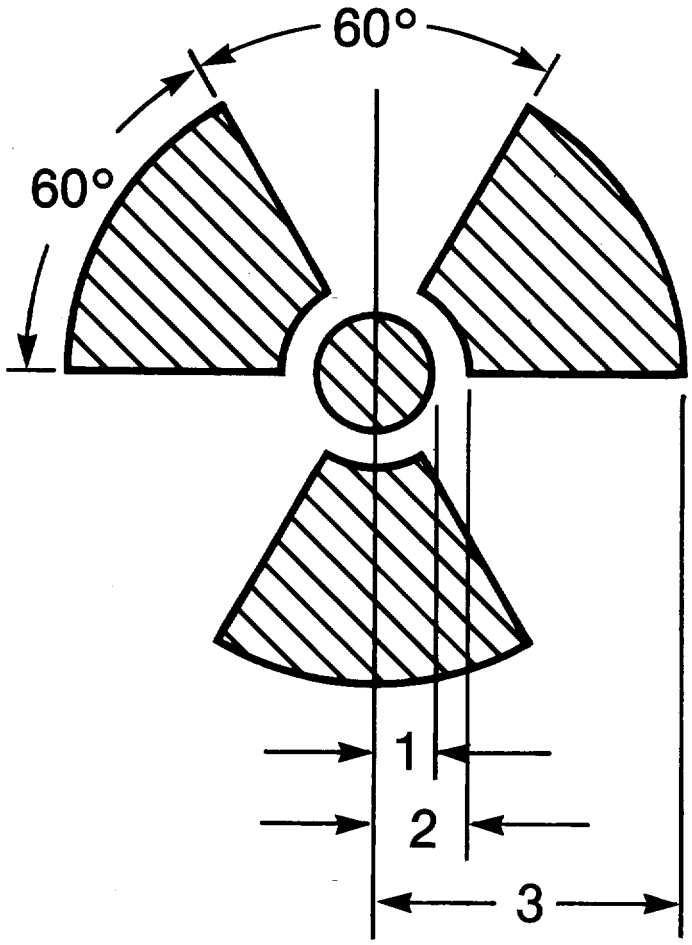
Compliance with the requirements of this subpart is required after October 1, 1997.

19. APPENDIX B is added to Part 172 to read as follows:

Appendix B to Part 172—Trefoil Symbol

The trefoil symbol required for RADIOACTIVE labels and placards, and required to be marked on certain packages of Class 7 (radioactive) material, must conform to the following design and size:

BILLING CODE 4910–60–P



BILLING CODE 4910–60–C

1= Radius of Circle—
Minimum Dimensions
4 mm (0.16 inch) for markings
5 mm (0.2 inch) for labels
12.5 mm (0.5 inch) for placards
2= 1 1/2 Radii
3= 5 Radii

PART 173—SHIPPERS—GENERAL REQUIREMENTS FOR SHIPMENTS AND PACKAGINGS

20. The authority citation for Part 173 continues to read as follows:

Authority: 49 U.S.C. 5101–5127; 49 CFR part 1.53.

§ 173.2a [Amended]

21. In § 173.2a(c)(5), the phrase ''§ 173.421–2'' is removed and replaced with the phrase ''§ 173.423''.

22. In § 173.4, paragraphs (a)(1)(iv) and (b) are revised to read as follows:

§ 173.4 Exceptions for small quantities.

(a) * * *

(1) * * *

(iv) An activity level not exceeding that specified in §§ 173.421, 173.424, 173.425 or 173.426, as appropriate, for a package containing a Class 7 (radioactive) material.

* * * * *

(b) A package containing a Class 7 (radioactive) material also must conform to the requirements of § 173.421(a)(1) through (a)(5) or § 173.424(a) through (g), as appropriate.

23. Subpart I of Part 173 is revised to read as follows:

Subpart I–Class 7 (Radioactive) Materials

Subpart I—Class 7 (Radioactive) Materials

§ 173.401 Scope.

(a) This subpart sets forth requirements for the packaging and transportation of Class 7 (radioactive) materials by offerors and carriers subject to this subchapter. The requirements prescribed in this subpart are in addition to, not in place of, other requirements set forth in this subchapter for Class 7 (radioactive) materials and those of the Nuclear Regulatory Commission in 10 CFR Part 71.

(b) This subpart does not apply to:

(1) Class 7 (radioactive) materials produced, used, transported, or stored within an establishment other than during the course of transportation, including storage in transportation.

(2) Class 7 (radioactive) materials contained in a medical device, such as a heart pacemaker, which is implanted in a human being or live animal.

(3) Class 7 (radioactive) materials that have been injected into, ingested by, or are otherwise placed into, and are still in, human beings or live animals.

§ 173.403 Definitions.

For purposes of this subpart—

A_1 means the maximum activity of special form Class 7 (radioactive) material permitted in a Type A package.

A_2 means the maximum activity of Class 7 (radioactive) material, other than special form, LSA or SCO, permitted in a Type A package. These values are either listed in § 173.435 or derived in accordance with the procedure prescribed in § 173.433.

Class 7 (radioactive) material. See the definition of *Radioactive material* in this section.

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

Containment system means the assembly of components of the packaging intended to retain the radioactive contents during transportation.

Conveyance means:

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

(2) For transport by water: any vessel, or any hold, compartment, or defined deck area of a vessel including any transport vehicle on board the vessel; and

(3) For transport by aircraft, any aircraft.

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

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

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

Fissile material, controlled shipment means any shipment that contains one or more packages that have been assigned, in accordance with § 173.457, nuclear criticality control transport indices greater than 10.

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

Highway route controlled quantity means a quantity within a single package which exceeds:

(1) 3,000 times the A_1 value of the radionuclides as specified in § 173.435 for special form Class 7 (radioactive) material;

(2) 3,000 times the A_2 value of the radionuclides as specified in § 173.435 for normal form Class 7 (radioactive) material; or

(3) 1,000 TBq (27,000 Ci), whichever is least.

Limited quantity of Class 7 (radioactive) material means a quantity of Class 7 (radioactive) material not exceeding the materials package limits specified in § 173.425 and conforming with requirements specified in § 173.421.

Low Specific Activity (LSA) material means Class 7 (radioactive) material with limited specific activity which satisfies the descriptions and limits set forth below. Shielding materials surrounding the LSA material may not be considered in determining the estimated average specific activity of the package contents. LSA material must be in one of three groups:

(1) *LSA–I.*

(i) Ores containing only naturally occurring radionuclides (e.g., uranium, thorium) and uranium or thorium concentrates of such ores; or

(ii) Solid unirradiated natural uranium or depleted uranium or natural thorium or their solid or liquid compounds or mixtures; or

(iii) Class 7 (radioactive) material, other than fissile material, for which the A_2 value is unlimited; or

(iv) Mill tailings, contaminated earth, concrete, rubble, other debris, and activated material in which the Class 7 (radioactive) material is essentially uniformly distributed and the average specific activity does not exceed $10^{-6}A_2/g$.

(2) *LSA–II.*

(i) Water with tritium concentration up to 0.8 TBq/liter (20.0 Ci/liter); or

(ii) Material in which the Class 7 (radioactive) material is essentially uniformly distributed and the average specific activity does not exceed $10^{-4}A_2/g$ for solids and gases, and $10^{-5}A_2/g$ for liquids.

(3) *LSA–III.* Solids (e.g., consolidated wastes, activated materials) that meet the requirements of § 173.468 and which:

(i) The Class 7 (radioactive) material is essentially uniformly distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.); and

(ii) The Class 7 (radioactive) material is relatively insoluble, or it is intrinsically contained in a relatively insoluble material, so that, even under loss of packaging, the loss of Class 7 (radioactive) material per package by leaching when placed in water for seven days would not exceed 0.1 A_2; and

(iii) The average specific activity of the solid does not exceed $2 \times 10^{-3}A_2/g$.

Low toxicity alpha emitters are:

(1) Natural uranium, depleted uranium, and natural thorium;

(2) Ores, concentrates or tailings containing uranium-235, uranium-238, thorium-232, thorium-228 and thorium-230; or

(3) Alpha emitters with a half-life of less than 10 days.

Maximum normal operating pressure means the maximum gauge pressure that would develop in a receptacle in a period of one year, in the absence of venting or cooling, under the heat conditions specified in 10 CFR 71.71(c)(1)

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

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

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

Normal form Class 7 (radioactive) material means Class 7 (radioactive) material which has not been demonstrated to qualify as ''special form Class 7 (radioactive) material.''

Package means, for Class 7 (radioactive) materials, the packaging together with its radioactive contents as presented for transport.

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

(2) ''Type A package'' means a packaging that, together with its radioactive contents limited to A_1 or A_2 as appropriate, meets the requirements of §§ 173.410 and 173.412 and is designed to retain the integrity of containment and shielding required by this part under normal conditions of transport as demonstrated by the tests set forth in § 173.465 or § 173.466, as appropriate. A Type A package does not require Competent Authority Approval.

(3) ''Type B package'' means a Type B packaging that, together with its radioactive contents, is designed to retain the integrity of containment and shielding required by this part when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR Part 71.

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

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

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

(i) ''Industrial package Type 1 (IP–1)'';

(ii) ''Industrial package Type 2 (IP–2)''; or

(iii) ''Industrial package Type 3 (IP–3)''.

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

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

TABLE 1.—NEUTRON FLUENCE RATES TO BE REGARDED AS EQUIVALENT TO A RADIATION LEVEL OF 0.01 mSv/h (1 mrem/h) [1]

Energy of neutron	Flux density equivalent to 0.01 mSv/h (1 mrem/h) neutrons per square centimeter per second ($n/cm^2/s$)
Thermal (2.510E–8)MeV	272.0
1 keV	272.0
10 keV	281.0
100 keV	47.0
500 keV	11.0
1 MeV	7.5
5 MeV	6.4
10 MeV	6.7

[1] Flux densities equivalent for energies between those listed in this table may be obtained by linear interpolation.

Radioactive contents means a Class 7 (radioactive) material, together with any contaminated liquids or gases within the package.

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

Radioactive material means any material having a specific activity greater than 70 Bq per gram (0.002 microcurie per gram) (see definition of ''specific activity'').

Special form Class 7 (radioactive) material means Class 7 (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 (0.2 inch); and

(3) It satisfies the test requirements of § 173.469. Special form encapsulations designed in accordance with the requirements of § 173.389(g) in effect on June 30, 1983 (see 49 CFR Part 173, revised as of October 1, 1982), and constructed prior to July 1, 1985 and special form encapsulations designed in accordance with the requirements of § 173.403 in effect on March 31, 1996 (see 49 CFR Part 173, revised as of October 1, 1995), and constructed prior to April 1, 1997, may continue to be used. Any other special form encapsulation must meet the requirements of this paragraph.

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

Surface Contaminated Object (SCO) means a solid object which is not itself radioactive but which has Class 7 (radioactive) material distributed on any of its surfaces. SCO must be in one of two groups with surface activity not exceeding the following limits:

(1) SCO–I: A solid object on which:

(i) The non-fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 4 Bq/cm^2 (10^{-4} microcurie/cm^2) for beta and gamma and low toxicity alpha emitters, or 0.4 Bq/cm^2 (10^{-5} microcurie/cm^2) for alpha emitters;

(ii) The fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 4×10^4 Bq/cm^2 (1.0 microcurie/cm^2) for beta and gamma and low toxicity alpha emitters, or 4×10^3 Bq/cm^2 (0.1 microcurie/cm^2) for all other alpha emitters; and

(iii) The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 4×10^4 Bq/cm^2 (1 microcurie/cm^2) for beta and gamma and low toxicity alpha emitters, or 4×10^3 Bq/cm^2 (0.1 microcurie/cm^2) for all other alpha emitters.

(2) SCO–II: A solid object on which the limits for SCO–I are exceeded and on which:

(i) The non-fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 400 Bq/cm^2 (10^{-2} microcurie/cm^2) for beta and gamma and low toxicity alpha emitters or 40 Bq/cm^2 (10^{-3} microcurie/cm^2) for all other alpha emitters;

(ii) The fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 8×10^5 Bq/cm^2 (20 microcurie/cm^2) for beta and gamma and low toxicity alpha emitters, or 8×10^4 Bq/cm^2 (2 microcuries/cm^2) for all other alpha emitters; and

(iii) The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 8×10^5 Bq/cm^2 (20 microcuries/cm^2) for beta and gamma and low toxicity alpha emitters, or 8×10^4 Bq/cm^2 (2 microcuries/cm^2) for all other alpha emitters.

Transport index (TI) means the dimensionless number (rounded up to the next tenth) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is determined as follows:

(1) For nonfissile material packages, the number determined by multiplying the maximum radiation level in milliSievert(s) per hour at one meter (3.3 feet) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at one meter (3.3 feet)); or

(2) For fissile material packages, the number determined by multiplying the maximum radiation level in milliSievert per hour at one meter (3.3 feet) from any external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at one meter (3.3 feet)) or, for criticality control purposes, the number obtained by dividing 50 by the allowable number of packages which may be transported together, whichever number is larger.

Type A quantity means a quantity of Class 7 (radioactive) material, the aggregate radioactivity which does not exceed A_1 for special form Class 7 (radioactive) material or A_2 for normal form Class 7 (radioactive) material, where A_1 and A_2 values are given in § 173.435 or are determined in accordance with § 173.433.

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

Unilateral approval means approval of a package solely by the competent authority of the country of origin.

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

Unirradiated uranium means uranium containing not more than 10^{-6} grams plutonium per gram of uranium-235 and a fission product activity of not more than 9 MBq (0.24 millicuries) of fission products per gram of uranium-235.

Uranium—natural, depleted or enriched means the following:

(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.

§ 173.410 General design requirements.

In addition to the requirements of subparts A and B of this part, each package used for the shipment of Class 7 (radioactive) materials must be designed so that—

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

(b) Each lifting attachment that is a structural part of the package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting attachment 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.

(c) The external surface, as far as practicable, will be free from protruding features and will be easily decontaminated.

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

(e) Each feature that is added to the package will not reduce the safety of the package.

(f) The package will be capable of withstanding the effects of any acceleration, vibration or vibration resonance (see § 178.608 of this subchapter) that may arise under normal conditions of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use (see §§ 173.24 and 173.24a).

(g) The materials of construction of the packaging and any components or structure will be physically and chemically compatible with each other and with the package contents. The behavior of the packaging and the package contents under irradiation will be taken into account.

(h) All valves through which the package contents could escape will be protected against unauthorized operation;

(i) For transport by air—

(1) The temperature of the accessible surfaces of the package will not exceed 50°C (122°F) at an ambient temperature of 38°C (100°F) with no account taken for insulation;

(2) The integrity of containment will not be impaired if the package is exposed to ambient temperatures ranging from −40°C (−40°F) to +55°C (131°F); and

(3) Packages containing liquid contents will be capable of withstanding, without leakage, an internal pressure that produces a pressure differential of not less than 95 kPa (13.8 lb/in^2).

§ 173.411 Industrial packagings.

(a) *General.* Each industrial packaging must comply with the requirements of this section which specifies packaging tests, and record retention applicable to Industrial Packaging Type 1 (IP–1), Industrial Packaging Type 2 (IP–2), and Industrial Packaging Type 3 (IP–3).

(b) *Industrial packaging certification and tests.* (1) Each IP–1 must meet the general design requirements prescribed in § 173.410.

(2) Each IP–2 must meet the general design requirements prescribed in § 173.410 and when subjected to the tests specified in § 173.465 (c) and (d) or evaluated against these tests by any of the methods authorized by § 173.461(a), must prevent:

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

(ii) A greater than 20% increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.

(3) Each IP–3 packaging must meet the requirements for an IP–1 and an IP–2, and must meet the requirements specified in § 173.412(a) through § 173.412(j).

(4) Each specification IM 101 or IM 102 portable tank (§§ 178.270, 178.271, 178.272 of this subchapter) that is certified as meeting the requirements for an IP–2 or IP–3 must:

(i) Satisfy the requirements for IP–2 or IP–3, respectively;

(ii) Be capable of withstanding a test pressure of 265 kPa (37.1 pounds per square inch) gauge;

(iii) Be designed so that any added shielding is capable of withstanding the static and dynamic stresses resulting from normal handling and normal conditions of transport; and

(iv) Be designed so that loss of shielding will not result in a significant increase in the radiation levels recorded at the external surfaces.

(5) Each freight container that is certified as meeting the requirements of IP–2 or IP–3, must—

(i) Satisfy the requirements for IP–2 or IP–3, respectively;

(ii) Be designed to conform to the requirements of ISO 1496–3–1995(E), ''Series 1 Freight Containers—Specifications and Testing—Part 3: Tank Containers for Liquids, Gases and Pressurized Dry Bulk'';

(iii) Be designed so that loss of shielding will not result in a significant increase in the radiation levels recorded at the external surfaces if they are subjected to the tests specified in ISO 1496/1–1995(E); and

(iv) For international transportation, have a safety approval plate in conformance with 49 CFR 451.21 through 451.25.

(c) Except for IP–1 packagings, each offeror of an industrial package must maintain on file for at least one year after the latest shipment, and shall provide to the Associate Administrator for Hazardous Materials Safety on request, complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification.

§ 173.412 Additional design requirements for Type A packages.

In addition to meeting the general design requirements prescribed in § 173.410, each Type A packaging must be designed so that—

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

(b) The smallest external dimension of the package is not less than 10 centimeters (4 inches).

(c) Containment and shielding is maintained during transportation and storage in a temperature range of −40°C (−40°F) to 70°C (158°F). Special attention shall be given to liquid contents and to the potential degradation of the packaging materials within the temperature range.

(d) The packaging must include a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form Class 7 (radioactive) material, as demonstrated in accordance with § 173.469, may be considered as a component of the containment system. If the containment system forms a separate unit of the package, it must be securely closed by a positive fastening device that is independent of any other part of the package.

(e) For each component of the containment system account is taken,

where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis.

(f) The containment system will retain its radioactive contents under the reduction of ambient pressure to 25 kPa (3.6 pounds per square inch).

(g) Each valve, other than a pressure relief device, is provided with an enclosure to retain any leakage.

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

(i) Failure of any tie-down attachment that is a structural part of the packaging, under both normal and accident conditions, must not impair the ability of the package to meet other requirements of this subpart.

(j) When evaluated against the performance requirements of this section and the tests specified in § 173.465 or using any of the methods authorized by § 173.461(a), the packaging will prevent—

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

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

(k) Each packaging designed for liquids will—

(1) Be designed to provide for ullage to accommodate variations in temperature of the contents, dynamic effects and filling dynamics;

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

(3) Either—

(i) Have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material must be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; or

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

(l) Each package designed for gases, other than tritium not exceeding 40 TBq (1000Ci) or noble gases not exceeding the A_2 value appropriate for the noble gas, will be able to prevent loss or dispersal of contents when the package is subjected to the tests prescribed in § 173.466 or evaluated against these tests by any of the methods authorized by § 173.461(a).

§ 173.413 Requirements for Type B packages.

Except as provided in § 173.416, each Type B(U) or Type B(M) package must be designed and constructed to meet the applicable requirements specified in 10 CFR Part 71.

§ 173.415 Authorized Type A packages.

The following packages are authorized for shipment if they do not contain quantities exceeding A_1 or A_2 as appropriate:

(a) DOT Specification 7A (§ 178.350 of this subchapter) Type A general packaging. Each offeror of a Specification 7A package must maintain on file for at least one year after the latest shipment, and shall provide to DOT on request, complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification. Use of Specification 7A packagings designed in accordance with the requirements of § 178.350 of this subchapter in effect on June 30, 1983 (see 49 CFR Part 178 revised as of October 1, 1982), is not authorized after April 1, 1997.

(b) Any other Type A packaging that also meets the applicable standards for fissile materials in 10 CFR Part 71 and is used in accordance with § 173.471.

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

(d) Any foreign-made packaging that meets the standards in IAEA ''Safety Series No. 6'' and bears the marking ''Type A'' and was used for the import of Class 7 (radioactive) materials. Such packagings may be subsequently used for domestic and export shipments of Class 7 (radioactive) materials provided the offeror obtains the applicable documentation of tests and engineering evaluations and maintains the documentation on file in accordance with paragraph (a) of this section. These packagings must conform with requirements of the country of origin (as indicated by the packaging marking) and the IAEA regulations applicable to Type A packagings.

§ 173.416 Authorized Type B packages.

Each of the following packages is authorized for shipment of quantities exceeding A_1 or A_2, as appropriate:

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

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

(c) DOT Specification 6M (§ 178.354 of this subchapter) metal packaging, only for solid or gaseous Class 7 (radioactive) materials that will not undergo pressure-generating decomposition at temperatures up to 121°C (250°F) and that do not generate more than 10 watts of radioactive decay heat.

(d) For contents in other than special form; DOT Specification 20WC (§ 178.362 of this subchapter), wooden protective jacket, when used with a single, snug-fitting inner DOT Specification 2R (§ 178.360 of this subchapter). For liquid contents, the inner packaging must conform to § 173.412(j) and (k).

(e) For contents in special form only; DOT Specification 20WC (§ 178.362 of this subchapter), wooden protective jacket, with a single snug-fitting inner Type A packaging that has a metal outer wall and conforms to § 178.350 of this subchapter. Radioactive decay heat may not exceed 100 watts.

(f) For contents in special form only; DOT Specification 21WC (§ 178.364 of this subchapter), wooden protective overpack, with a single inner DOT Specification 2R (§ 178.360 of this subchapter). Contents must be loaded within the inner packaging in such a manner as to prevent loose movement during transportation. The inner packaging must be securely positioned and centered within the overpack so that there will be no significant displacement of the inner packaging if subjected to the 9 meter (30 feet) drop test described in 10 CFR part 71.

§ 173.417 Authorized fissile materials packages.

(a) Except as provided in § 173.453, fissile materials containing not more than A_1 or A_2 as appropriate, must be packaged in one of the following packagings:

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

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

(3) Any packaging listed in § 173.415, limited to the Class 7 (radioactive) materials specified in 10 CFR part 71, subpart C.

(4) Any other Type A or Type B, Type B(U), or Type B(M) packaging for fissile Class 7 (radioactive) materials that also meets the applicable standards for fissile materials in 10 CFR part 71.

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

(6) A 55-gallon 1A2 steel drum, meeting the applicable packaging testing requirements of subpart M of Part 178 of this subchapter at the packing group I performance level, subject to the following conditions:

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

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

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

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

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

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

(vii) Liquid contents must be packaged in accordance with § 173.412 (j) and (k); and

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

TABLE 2.—FISSILE MATERIAL CONTENT AND TRANSPORT INDEX FOR UN1A2 PACKAGE

Maximum quantity and minimum transport index		Maximum No. of packages transported as a fissile material controlled shipment
U–235 per package (grams)	Minimum transport index per package	
350	1.8	72
300	1.0	129
250	0.5	256
200	0.3	500
150	0.1	500
100	0.1	500
50	(1)	(2)

[1] Transport index is limited by the external radiation levels.
[2] Maximum number is limited by the total transport index.

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

TABLE 3.—ALLOWABLE CONTENT OF URANIUM HEXAFLUORIDE (UF_6) ''HEELS'' IN A SPECIFICATION 7A CYLINDER

	Maximum cylinder diameter		Cylinder volume		Maximum Uranium-235 enrichment (weight percent)	Maximum ''Heel'' weight per cylinder		
	Centimeters	Inches	Liters	Cubic Feet		UF6	Uranium-235	
							kg	(lb)
12.7	5	8.8	0.311	100.0	0.045	0.1	0.031	0.07
20.3	8	39.0	1.359	12.5	0.227	0.5	0.019	0.04
30.5	12	68.0	2.410	5.0	0.454	1.0	0.015	0.03
76.0	30	725.0	25.64	5.0	11.3	25.0	0.383	0.84
122.0	48	3,084.0	[1] 108.9	4.5	22.7	50.0	0.690	1.52
122.0	48	4,041.0	[2] 142.7	4.5	22.7	50.0	0.690	1.52

[1] 10 ton.
[2] 14 ton.

(8) DOT Specification 20PF–1, 20PF–2, or 20PF–3 (§ 178.356 of this subchapter), or Specification 21PF–1A, 21PF–1B, or 21PF–2 (§ 178.358 of this subchapter) phenolic-foam insulated overpack with snug fitting inner metal cylinders, meeting all requirements of §§ 173.24, 173.410, 173.412, and 173.420 and the following:

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

(ii) Quantities of uranium hexafluoride are authorized as shown in Table 6 of this section, with each package assigned a minimum transport index as also shown.

(b) Fissile Class 7 (radioactive) materials with radioactive content exceeding A_1 or A_2 must be packaged in one of the following packagings:

(1) DOT Specification 6L (§ 178.352 of this subchapter), metal packaging. These packages may contain only uranium-235, plutonium-239, or plutonium-241, as metal, oxide, or compounds that do not decompose at temperatures up to 149°C (300°F). Radioactive decay heat output may not exceed 5 watts. Class 7 (radioactive) materials in normal form must be packaged in one or more tightly sealed metal or polyethylene bottles within a DOT Specification 2R (§ 178.360 of this subchapter) containment vessel. Authorized contents are limited in accordance with Table 4, as follows:

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

Uranium-235		Plutonium (Plutonium solutions are not authorized)		Minimum fissile transport index	Maximum No. of packages transported as a fissile material control shipment
H/X<=3[1]	3 H/X<= 10	H/X<= 10	10 <= H/X <= 20		
14	[2] 3.6	.....	.....	1.3	80
.....	.....	2.5	2.4	1.8	50

[1] H/X is the ratio of hydrogen to fissile atoms in their inner containment with all sources of hydrogen in the containment considered.
[2] Volume not to exceed 3.6 liters.

(2) DOT Specification 6M (§ 178.354 of this subchapter), metal packaging. These packages must contain only solid Class 7 (radioactive) materials that will not decompose at temperatures up to 121°C (250°F). Radioactive decay heat output may not exceed 10 watts. Class 7 (radioactive) materials in other than special form must be packaged in one or more tightly sealed metal cans or polyethylene bottles within a DOT Specification 2R (§ 178.360 of this subchapter) containment vessel.

(i) Packages are limited to the following amounts of fissile Class 7 (radioactive) materials: 1.6 kilograms of uranium-235; 0.9 kilograms of plutonium (except that due to the 10-watt thermal decay heat limitation, the limit for plutonium-238 is 0.02 kilograms); and 0.5 kilograms of uranium-233. The maximum ratio of hydrogen to fissile material may not exceed three, including all of the sources of hydrogen within the DOT Specification 2R containment vessel.

(ii) Maximum quantities of fissile material and other restrictions are given in Table 5. The minimum transport index to be assigned per package and for fissile material, controlled shipments and the allowable number of similar packages per conveyance and per transport vehicle are shown in Table 5. Where a maximum ratio of hydrogen to fissile material is specified in Table 5, only the hydrogen interspersed with the fissile material need be considered. For a uranium-233 shipment, the maximum inside diameter of the inner containment vessel may not exceed 12.1 centimeters (4.75 inches). Where necessary, a tight fitting steel insert must be used to reduce a larger diameter inner containment vessel specified in § 178.354 of this subchapter to the 12.1 centimeter (4.75 inch) limit. Table 5 is as follows:

TABLE 5.—AUTHORIZED CONTENTS FOR SPECIFICATION 6M PACKAGES [1]

Uranium-233[5]			Uranium-235[4 7]			Plutonium[2 3 4]			Minimum transport index	Maximum No. pkgs. transported as a fissile material control shipment
Metal or alloy	Compounds		Metal or alloy	Compounds		Metal or alloy	Compounds			
H/X=0[8]	H/X=0	H/X<=3	H/X=0	H/X=0	H/X<=3	H/X=0	H/X=0	H/X<=3		
0.5	0.5	0.5	1.6	1.6	1.6	[9] 0.9	[9] 0.9	[9] 0.9	0	NA
3.6	4.4	2.9	7.2	7.6	5.3	3.1	4.1	3.4	0.1	1,250
4.2[6]	5.2	3.5	8.7	9.6	6.4	3.4	4.5	4.1	0.2	625
5.2[6]	6.8	4.5	11.2	13.9	8.3	4.2	.....	4.5	0.5	250
.....	.....	.....	13.5	16.0	10.1	4.5	.....	.....	1.0	125
.....	.....	.....	.....	26.0	16.1	.....	.....	.....	5.0	25
.....	.....	.....	.....	32.0	19.5	.....	.....	.....	10.0	12

[1] Quantity in kilograms.
[2] Minimum percentage of plutonium-240 is 5 weight percent.
[3] 4.5 kilogram limitation of plutonium due to watt decay heat limitation.
[4] For a mixture of uranium-235 and plutonium an equal amount of uranium-235 may be substituted for any portion of the plutonium authorized.
[5] Maximum inside diameter of specification 2R containment vessel not to exceed 12.1 centimeters (4.75 inches) (see paragraph (b)(2)(ii) of this section).
[6] Granulated or powdered metal with any particle less than 6.4 millimeters (0.25 inch) in the smallest dimension is not authorized.
[7] Maximum permitted uranium-235 enrichment is 93.5 percent.
[8] H/X is the ratio of hydrogen to fissile atoms in the inner containment.
[9] For P–238, the limit is 0.02 kg because of the 10 watt thermal decay heat limitation.

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

(4) Type B, B(U), or B(M) packaging that meets the applicable requirements for fissile Class 7 (radioactive) materials in Section V of the IAEA ''Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6'' and for which the foreign competent authority certificate has been revalidated by the U.S. Competent Authority in accordance with § 173.473. These packagings are authorized only for import and export shipments.

(5) DOT Specifications 20PF–1, 20PF–2, or 20PF–3 (§ 178.356 of this subchapter), or DOT Specifications 21PF–1A or 21PF–1B (§ 178.358 of this subchapter) phenolic-foam insulated overpack with snug fitting inner metal cylinders, meeting all requirements of §§ 173.24, 173.410, and 173.412, and the following:

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

(ii) Quantities of uranium hexafluoride are authorized as shown in Table 6, with each package assigned a minimum transport index as also shown:

TABLE 6.—AUTHORIZED QUANTITIES OF URANIUM HEXAFLUORIDE

Protective overpack specification number	Maximum inner cylinder diameter		Maximum weight of UF6 contents		Maximum U–235 enrichment (weight/percent)	Minimum transport index
	Centimeters	Inches	Kilograms	Pounds		
20PF–1	12.7	5	25	55	100.0	0.1
20PF–2	20.3	8	116	255	12.5	0.4
20PF–3	30.5	12	209	460	5.0	1.1
21PF–1A[1] or 21PF–1B[1]	[2]76.0	[2]30	2,250	4,950	5.0	5.0
21PF–1A[1] or 21PF–1B[1]	[3]76.0	[3]30	2,282	5,020	5.0	5.0
21PF–2[1]	[2]76.0	[2]30	2,250	4,950	5.0	5.0
21PF–2[1]	[3]76.0	[3]30	2,282	5,020	5.0	5.0

[1] For 76 cm (30 in) cylinders, the maximum H/U atomic ratio is 0.088.
[2] Model 30A inner cylinder (reference ORO–651).
[3] Model 30B inner cylinder (reference ORO–651).

§ 173.418 Authorized packages—pyrophoric Class 7 (radioactive) materials.

Pyrophoric Class 7 (radioactive) materials, as referenced in the § 172.101 Table of this subchapter, in quantities not exceeding A_2 per package must be transported in DOT Specification 7A packagings constructed of materials that will not react with, nor be decomposed by, the contents. Contents of the package must be—

(a) In solid form and must not be fissile unless excepted by § 173.453;

(b) Contained in sealed and corrosion resistant receptacles with positive closures (friction or slip-fit covers or stoppers are not authorized);

(c) Free of water and contaminants that would increase the reactivity of the material; and

(d) Inerted to prevent self-ignition during transport by either—

(1) Mixing with large volumes of inerting materials, such as graphite, dry sand, or other suitable inerting material, or blended into a matrix of hardened concrete; or

(2) Filling the innermost receptacle with an appropriate inert gas or liquid.

§ 173.419 Authorized packages—oxidizing Class 7 (radioactive) materials.

(a) An oxidizing Class 7 (radioactive) material, as referenced in the § 172.101 Table of this subchapter, is authorized in quantities not exceeding an A_2 per package, in a DOT Specification 7A package provided that—

(1) The contents are:

(i) Not fissile;

(ii) Packed in inside packagings of glass, metal or compatible plastic; and

(iii) Cushioned with a material that will not react with the contents; and

(2) The outside packaging is made of wood, metal, or plastic.

(b) The package must be capable of meeting the applicable test requirements of § 173.465 without leakage of contents.

(c) For shipment by air, the maximum quantity in any package may not exceed 11.3 kilograms (25 pounds).

§ 173.420 Uranium hexafluoride (fissile, fissile excepted and non-fissile).

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

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

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

(i) American National Standard N14.1 (1990, 1987, 1982, 1971) in effect at the time the packaging was manufactured;

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

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

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

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

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

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

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

(3) Uranium hexafluoride must be in solid form.

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

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

(b) Packagings for uranium hexafluoride must be periodically inspected, tested, marked and otherwise conform with the American National Standard N14.1–1990.

(c) Each repair to a packaging for uranium hexafluoride must be performed in accordance with American National Standard N14.1–1990.

§ 173.421 Excepted packages for limited quantities of Class 7 (radioactive) materials.

(a) A Class 7 (radioactive) material whose activity per package does not exceed the limits specified in § 173.425 and its packaging are excepted from the specification packaging, marking, labeling and, if not a hazardous substance or hazardous waste, the shipping paper and certification requirements of this subchapter and requirements of this subpart if:

(1) Each package meets the general design requirements of § 173.410;

(2) The radiation level at any point on the external surface of the package does not exceed 0.005 mSv/hour (0.5 mrem/hour);

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

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

(5) Except as provided in § 173.426, the package does not contain more than 15 grams of uranium-235; and

(6) The material is otherwise prepared for shipment as specified in accordance with § 173.422.

(b) A limited quantity of Class 7 (radioactive) material that is a hazardous substance or a hazardous waste, is not subject to the provisions in § 172.203(d) or § 172.204(c)(4) of this subchapter.

§ 173.422 Additional requirements for excepted packages containing Class 7 (radioactive) materials.

(a) Excepted packages prepared for shipment under the provisions of § 173.421, § 173.424, § 173.426, or § 173.428 must be certified as being acceptable for transportation by having a notice enclosed in or on the package, included with the packing list, or otherwise forwarded with the package. This notice must include the name of the consignor or consignee and one of the following statements, as appropriate:

(1) ''This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910'';

(2) ''This package conforms to the conditions and limitations specified in 49 CFR 173.424 for radioactive material, excepted package-instruments or articles, UN2910'';

(3) ''This package conforms to the conditions and limitations specified in 49 CFR 173.426 for radioactive material, excepted package-articles manufactured from natural or depleted uranium, or natural thorium, UN2910''; or

(4) ''This package conforms to the conditions and limitations specified in 49 CFR 173.428 for radioactive material, excepted package-empty packaging, UN2910.''

(b) An excepted package of Class 7 (radioactive) material that is classed as Class 7 and is prepared for shipment under the provisions of § 173.421, § 173.423, § 173.424, § 173.426, or § 173.428 is not subject to the requirements of this subchapter, except for—

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

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

§ 173.423 Requirements for multiple hazard limited quantity Class 7 (radioactive) materials.

(a) Except as provided in § 173.4, when a limited quantity radioactive material meets the definition of another hazard class or division, it must be—

(1) Classed for the additional hazard;

(2) Packaged to conform with the requirements specified in § 173.421(a)(1) through (a)(5) or § 173.424(a) through (g), as appropriate; and

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

(b) A limited quantity Class 7 (radioactive) material which is classed other than Class 7 in accordance with this subchapter is excepted from the requirements of §§ 173.422(a), 172.203(d), and 172.204(c)(4) of this subchapter if the entry ''Limited quantity radioactive material'' appears on the shipping paper in association with the basic description.

§ 173.424 Excepted packages for radioactive instruments and articles.

A radioactive instrument or article and its packaging is excepted from the specification packaging, shipping paper and certification, marking and labeling requirements of this subchapter and requirements of this subpart, if:

(a) Each package meets the general design requirements of § 173.410;

(b) The activity of the instrument or article does not exceed the relevant limit listed in Table 7 in § 173.425;

(c) The total activity per package does not exceed the relevant limit listed in Table 7 in § 173.425;

(d) The radiation level at 10 cm (4 in) from any point on the external surface of any unpackaged instrument or article does not exceed 0.1 mSv/hour (10 mrem/hour);

(e) The radiation level at any point on the external surface of a package bearing the article or instrument does not exceed 0.005 mSv/hour (0.5 mrem/hour), or, for exclusive use domestic shipments, 0.02 mSv (2 mrem/hour);

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

(g) Except as provided in § 173.426, the package does not contain more than 15 grams of uranium-235; and

(h) The package is otherwise prepared for shipment as specified in § 173.422.

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

The limits applicable to instruments, articles, and limited quantities subject to exceptions under §§ 173.421 and 173.424 are set forth in Table 7 as follows:

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

Nature of contents	Instruments and articles		Materials package limits [1]
	Limits for each instrument or article [1]	Package limits [1]	
Solids:			
Special form	$10^{-2}A_1$	A_1	$10^{-3}A_14$
Other form	$10^{-2}A_2$	A_2	$10^{-3}A_2$
Liquids—Tritiated water:			
<0.0037 TBq/liter (0.1 Ci/L)			37 TBq (1,000 Ci)
0.0037 TBq to 0.037 TBq/L (0.1 Ci to 1.0 Ci/L)			3.7 TBq (100 Ci)
>0.037 TBq/L (1.0 Ci/L)			0.037 TBq (1.0 Ci)
Other Liquids	$10^{-3}A_2$	$10A^1A_2$	$10^{-4}A_2$
Gases:			
Tritium	$2 \times 10^{-2}A_2$	$2 \times 10^{-1}A_2$	$2 \times 10^{-2}A_2$
Special form	$10^{-3}A_1$	$10^{-2}A_1$	$10^{-3}A_1$
Other form	$10^{-3}A_2$	$10^{-2}A_2$	$10^{-3}A_2$

[1] For mixtures of radionuclides see § 173.433(b).

§ 173.426 Excepted packages for articles containing natural uranium or thorium.

A manufactured article in which the sole Class 7 (radioactive) material content is natural or unirradiated depleted uranium or natural thorium and its packaging is excepted from the specification packaging, shipping paper and certification, marking, and labeling requirements of this subchapter and requirements of this subpart if:

(a) Each package meets the general design requirements of § 173.410;

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

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

(d) The article is otherwise prepared for shipment as specified in § 173.422.

§ 173.427 Transport requirements for low specific activity (LSA) Class 7 (radioactive) materials and surface contaminated objects (SCO).

(a) In addition to other applicable requirements specified in this subchapter, low specific activity (LSA) materials and surface contaminated objects (SCO), unless excepted by paragraph (d) of this section, must be packaged in accordance with paragraph (b) or (c) of this section and must be transported in accordance with the following conditions:

(1) The external dose rate must not exceed an external radiation level of 10 mSv/h (1 rem/h) at 3 meters from the unshielded material;

(2) The quantity of LSA and SCO material in any single conveyance must not exceed the limits specified in Table 9;

(3) LSA material and SCO that are or contain fissile material must meet the applicable requirements of § 173.451;

(4) Packages must meet the contamination control limits specified in § 173.443;

(5) External radiation levels must comply with § 173.441; and

(6) For LSA material and SCO required by this section to be consigned as exclusive use:

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

(ii) There must be no loose Class 7 (radioactive) material in the conveyance, however, when the conveyance is the packaging there must be no leakage of Class 7 (radioactive) material from the conveyance;

(iii) Packages must be braced so as to prevent shifting of lading under conditions normally incident to transportation;

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

(v) Except for shipments of unconcentrated uranium or thorium ores, the transport vehicle must be placarded in accordance with subpart F of Part 172 of this subchapter;

(vi) For domestic transportation only, packages are excepted from the marking and labeling requirements of this subchapter. However, the exterior of each nonbulk package must be stenciled or otherwise marked ''Radioactive—LSA'' or ''Radioactive—SCO'', as appropriate, and nonbulk packages that contain a hazardous substance must also be stenciled or otherwise marked with the letters ''RQ'' in association with the above description; and

(vii) Except when transported in an industrial package in accordance with Table 8, transportation by aircraft is prohibited.

(b) Except as provided in paragraph (c) of this section, LSA material and SCO must be packaged as follows:

(1) In an industrial package (IP–1, IP–2 or IP–3; § 173.411), subject to the limitations of Table 8;

(2) For domestic transportation only, in a DOT Specification 7A (§ 178.350 of this subchapter) Type A package. The requirements of § 173.412 (a), (b), (c) and (k) do not apply; or

(3) For domestic transportation only, in a strong, tight package that prevents leakage of the radioactive content under normal conditions of transport. In addition to the requirements of paragraph (a) of this section, the following requirements must be met:

(i) The shipment must be exclusive use;

(ii) The quantity of Class 7 (radioactive) material in each packaging may not exceed an A_2 quantity.

(c) LSA–I and SCO–I (see § 173.403), unless packaged in accordance with paragraph (b) of this section, must be packaged in bulk packagings in accordance with this paragraph. The shipment must be, in addition to complying with the applicable requirements of paragraph (a) of this section, exclusive use:

(1) *Solids.* Packages must be strong tight packagings, meeting the requirements of subpart B of this Part, transported in a closed transport vehicle. The requirements of § 173.410 do not apply.

(2) *Liquids.* Liquids must be transported in the following packagings:

(i) Specification 103CW, 111A60W7 (§§ 179.200, 179.201, 179.202 of this

subchapter) tank cars. Bottom openings in tanks are prohibited; or

(ii) Specification MC 310, MC 311, MC 312, MC 331 or DOT 412 (§ 178.348 or § 178.337 of this subchapter) cargo tank motor vehicles. Bottom outlets are not authorized. Trailer-on-flat-car service is not authorized.

(d) Except for transportation by aircraft, LSA material and SCO that conform to the provisions specified in 10 CFR 20.2005 are excepted from all requirements of this subchapter pertaining to Class 7 (radioactive) materials when offered for transportation for disposal or recovery. A material which meets the definition of another hazard class is subject to the provisions of this subchapter relating to that hazard class.

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

(f) Tables 8 and 9 are as follows:

TABLE 8.—INDUSTRIAL PACKAGE INTEGRITY REQUIREMENTS FOR LSA MATERIAL AND SCO

Contents	Industrial packaging type	
	Exclusive use shipment	Nonexclusive use shipment
LSA–I:		
Solid	IP–1	IP–1
Liquid	IP–1	IP–2
LSA–II:		
Solid	IP–2	IP–2
Liquid and gas	IP–2	IP–3
LSA–IIII	IP–2	IP–3
SCO–I	IP–1	IP–1
SCO–II	IP–2	IP–2

TABLE 9—CONVEYANCE ACTIVITY LIMITS FOR LSA MATERIAL AND SCO

Nature of material	Activity limit for conveyances
LSA–I	No limit.
LSA–II and LSA–III; noncombustible solids.	No limit.
LSA–II and LSA–III; Combustible solids and all liquids and gases.	100 A_2
SCO	100 A_2

§ 173.428 Empty Class 7 (radioactive) materials packaging.

A packaging which previously contained Class 7 (radioactive) materials and has been emptied of contents as far as practical, is expected from the shipping paper and certification, marking and labeling requirements of this subchapter, and from requirements of this chapter, provided that—

(a) The packaging meets the requirements of § 173.421(b), (c), and (e) of this subpart;

(b) The packaging is in unimpaired condition and is securely closed so that there will be no leakage of Class 7 (radioactive) material under conditions normally incident to transportation;

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

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

(e) The packaging is prepared for shipment as specified in § 173.422.

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

(a) Except for LSA material and SCO, a Type A package may not contain a quantity of Class 7 (radioactive) materials greater than A_1 for special form Class 7 (radioactive) material or A_2 for normal form Class 7 (radioactive) material as listed in § 173.435, or, for Class 7 (radioactive) materials not listed in § 173.435, as determined in accordance with § 173.433.

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

§ 173.433 Requirements for determining A_1 and A_2 values for radionuclides and for the listing of radionuclides on shipping papers and labels.

(a) Values of A_1 and A_2 for individual radionuclides that are the basis for many activity limits elsewhere in this subchapter are given in the table in § 173.435.

(b) For individual radionuclides whose identities are known, but which are not listed in the table in § 173.435, the determination of the values of A^1 and A_2 requires approval from the Associate Administrator for Hazardous Materials Safety except that the values of A_1 and A_2 in Table 10 may be used without obtaining approval from Associate Administrator for Hazardous Materials Safety.

(c) In calculating A_1 and A_2 values for a radionuclide not listed in the table in § 173.435, a single radioactive decay chain in which the radionuclides are present in their naturally-occurring proportions, and in which no daughter nuclide has a half life either longer than 10 days or longer than that of the parent nuclide, will be considered as a single radionuclide, and the activity to be taken into account and the A_1 or A_2 value to be applied will be those corresponding to the parent nuclide of that chain. Otherwise, the parent and daughter nuclides will be considered as a mixture of different nuclides.

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

(1) For special form Class 7 (radioactive) material:

$$\sum_i \frac{B(i)}{A_1(i)} \quad \text{less than or equal to 1}$$

Where B(i) is the activity of radionuclide i and $A_1(i)$ is the A_1 value for radionuclide i; or

(2) For other forms of Class 7 (radioactive) material, either—

$$\sum_i \frac{B(i)}{A_2(i)} \quad \text{less than or equal to 1}$$

Where B(i) is the activity of radionuclide i and $A_2(i)$ is the A_2 value for radionuclide i; or

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

where f(i) is the fraction of activity of nuclide i in the mixture and $A_2(i)$ is the appropriate A_2 value for nuclide i.

(e) When the identity of each nuclide is known but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest A_1 or A_2 value, as appropriate, for the radionuclides in each group may be used in applying the formulas in paragraph (d) of this section. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest A_1 or A_2 values for the alpha emitters or beta/gamma emitters, respectively.

(f) *Shipping papers and labeling. (1)* For mixtures of radionuclides, the radionuclides (n) that must be shown on shipping papers and labels in accordance with §§ 172.203 and 172.403 of this subchapter, respectively, must be determined on the basis of the following formula:

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

Where n + m represents all the radionuclides in the mixture, m are the radionuclides that do not need to be considered, a_i is the activity of radionuclide i in the mixture, and A_i is the A_1 or A_2 value, as appropriate for radionuclide i.

(g) Table 10 is as follows:

TABLE 10.—GENERAL VALUES FOR A_1 and A_2

Contents	A_1		A_2	
	(TBq)	(Ci)	(TBq)	(Ci)
Only beta or gamma emitting nuclides are known to be present	0.2	5	0.02	0.5
Alpha emitting nuclides are known to be present or relevant data are available	0.10	2.70	2×10^{-5}	5.41×10^{-4}

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

The table of activity-mass relationships for uranium and natural thorium are as follows:

Thorium and uranium enrichment[1](Wt% ^{235}U present)	Specific activity			
	TBq/gram	Grams/Tbq	Ci/gram	Grams/Ci
0.45 (depleted)	1.9×10^{-8}	5.4×10^{7}	5.0×10^{-7}	2.0×10^{6}
0.72 (natural)	2.6×10^{-8}	3.8×10^{7}	7.1×10^{-7}	1.4×10^{6}
1.0	2.8×10^{-8}	3.6×10^{7}	7.6×10^{-7}	1.3×10^{6}
1.5	3.7×10^{-8}	2.7×10^{7}	1.0×10^{-6}	1.0×10^{6}
5.0	1.0×10^{-7}	1.0×10^{7}	2.7×10^{-6}	3.7×10^{5}
10.0	1.8×10^{-7}	5.6×10^{6}	4.8×10^{-6}	2.1×10^{5}
20.0	3.7×10^{-7}	2.7×10^{6}	1.0×10^{-5}	1.0×10^{5}
35.0	7.4×10^{-7}	1.4×10^{6}	2.0×10^{-5}	5.0×10^{4}
50.0	9.3×10^{-7}	1.1×10^{6}	2.5×10^{-5}	4.0×10^{4}
90.0	2.1×10^{-6}	4.7×10^{5}	5.8×10^{-5}	1.7×10^{4}
93.0	2.6×10^{-6}	3.9×10^{5}	7.0×10^{-5}	1.4×10^{4}
95.0	3.4×10^{-6}	3.0×10^{5}	9.1×10^{-5}	1.1×10^{4}
Natural thorium	8.1×10^{-9}	1.2×10^{8}	2.2×10^{-7}	4.6×10^{6}

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

§ 173.435 Table of A_1 and A_2 values for radionuclides.

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

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Ac-225	Actinium(89)	0.6	16.2	1×10^{-2}	0.270	2.1×10^{3}	5.8×10^{4}
Ac-227		40	1080	2×10^{-5}	5.41×10^{-4}	2.7	7.2×10^{1}
Ac-228		0.6	16.2	0.4	10.8	8.4×10^{4}	2.2×10^{6}
Ag-105	Silver(47)	2	54.1	2	54.1	1.1×10^{3}	3.0×10^{4}
Ag-108m		0.6	16.2	0.6	16.2	9.7×10^{-1}	2.6×10^{1}
Ag-110m		0.4	10.8	0.4	10.8	1.8×10^{3}	4.7×10^{3}
Ag-111		0.6	16.2	0.5	13.5	5.8×10^{3}	1.6×10^{5}
Al-26	Aluminum(13)	0.4	10.8	0.4	10.8	7.0×10^{-4}	1.9×10^{-2}
Am-241	Americium(95)	2	54.1	2×10^{-4}	5.41×10^{-3}	1.3×10^{1}	3.4
Am-242m		2	54.1	2×10^{-4}	5.41×10^{-3}	3.6×10^{-1}	9.7×10^{5}
Am-243		2	54.1	2×10^{-4}	5.41×10^{-3}	7.4×10^{-3}	2.0×10^{-1}
Ar-37	Argon(18)	40	1080	40	1080	3.7×10^{3}	9.9×10^{4}
Ar-39		20	541	20	541	1.3×10^{3}	3.4×10^{1}
Ar-41		0.6	16.2	0.6	16.2	1.5×10^{6}	4.2×10^{7}
Ar-42		0.2	5.41	0.2	5.41	9.6	2.6×10^{2}
As-72	Arsenic(33)	0.2	5.41	0.2	5.41	6.2×10^{4}	1.7×10^{6}
As-73		40	1080	40	1080	8.2×10^{2}	2.2×10^{4}
As-74		1	27.0	0.5	13.5	3.7×10^{3}	9.9×10^{4}
As-76		0.2	5.41	0.2	5.41	5.8×10^{4}	1.6×10^{6}
As-77		20	541	0.5	13.5	3.9×10^{4}	1.0×10^{6}
At-211	Astatine(85)	30	811	2	54.1	7.6×10^{4}	2.1×10^{6}
Au-193	Gold(79)	6	162	6	162	3.4×10^{4}	9.2×10^{5}
Au-194		1	27.0	1	27.0	1.5×10^{4}	4.1×10^{5}
Au-195		10	270	10	270	1.4×10^{2}	3.7×10^{3}
Au-196		2	54.1	2	54.1	4.0×10^{3}	1.1×10^{5}
Au-198		3	81.1	0.5	13.5	9.0×10^{3}	2.4×10^{5}
Au-199		10	270	0.9	24.3	7.7×10^{3}	2.1×10^{5}
Ba-131	Barium(56)	2	54.1	2	54.1	3.1×10^{3}	8.4×10^{4}
Ba-133m		10	270	0.9	24.3	2.2×10^{4}	6.1×10^{5}
Ba-133		3	81.1	3	81.1	9.4	2.6×10^{2}
Ba-140		0.4	10.8	0.4	10.8	2.7×10^{3}	7.3×10^{4}
Be-7	Beryllium(4)	20	541	20	541	1.3×10^{4}	3.5×10^{5}

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Be-10		20	541	0.5	13.5	8.3×10^{-4}	2.2×10^{-2}
Bi-205	Bismuth(83)	0.6	16.2	0.6	16.2	1.5×10^{3}	4.2×10^{4}
Bi-206		0.3	8.11	0.3	8.11	3.8×10^{3}	1.0×10^{5}
Bi-207		0.7	18.9	0.7	18.9	1.9	5.2×10^{1}
Bi-210m		0.3	8.11	3×10^{-2}	0.811	2.1×10^{-5}	5.7×10^{-4}
Bi-210		0.6	16.2	0.5	13.5	4.6×10^{3}	1.2×10^{5}
Bi-212		0.3	8.11	0.3	8.11	5.4×10^{5}	1.5×10^{7}
Bk-247	Berkelium(97)	2	54.1	2×10^{-4}	5.41×10^{-3}	3.8×10^{-2}	1.0
Bk-249		40	1080	8×10^{-2}	2.16	6.1×10^{1}	1.6×10^{3}
Br-76	Bromine(35)	0.3	8.11	0.3	8.11	9.4×10^{4}	2.5×10^{6}
Br-77		3	81.1	3	81.1	2.6×10^{4}	7.1×10^{5}
Br-82		0.4	108	0.4	10.8	4.0×10^{4}	1.1×10^{6}
C-11	Carbon(6)	1	270	0.5	13.5	3.1×10^{7}	8.4×10^{8}
C-14		40	1080	2	54.1	1.6×10^{-1}	4.5
Ca-41	Calcium(20)	40	1080	40	1080	3.1×10^{-3}	8.5×10^{-2}
Ca-45		40	1080	0.9	24.3	6.6×10^{2}	1.8×10^{4}
Ca-47		0.9	24.3	0.5	13.5	2.3×10^{4}	6.1×10^{5}
Cd-109	Cadmium(48)	40	1080	1	27.0	9.6×10^{1}	2.6×10^{3}
Cd-113m		20	541	9×10^{-2}	2.43	8.3×10^{4}	2.2×10^{2}
Cd-115m		0.3	8.11	0.3	8.11	9.4×10^{2}	2.5×10^{4}
Cd-115		4	108	0.5	13.5	1.9×10^{4}	5.1×10^{5}
Ce-139	Cerium(58)	6	162	6	162	2.5×10^{26}	$.8\times10^{3}$
Ce-141		10	270	0.5	13.5	1.1×10^{3}	2.8×10^{4}
Ce-143		0.6	16.2	0.5	13.5	2.5×10^{4}	6.6×10^{5}
Ce-144		0.2	5.41	0.2	5.41	1.2×10^{2}	3.2×10^{3}
Cf-248	Californium (98)	30	811	3×10^{-3}	8.11×10^{-2}	5.8×10^{1}	1.6×10^{3}
Cf-249		2	54.1	2×10^{-4}	5.41×10^{-3}	1.5×10^{-1}	4.1
Cf-250		5	135	5×10^{-4}	1.35×10^{-2}	4.0	1.1×10^{2}
Cf-251		2	54.1	2×10^{-4}	5.41×10^{-3}	5.9×10^{-2}	1.6
Cf-252		0.1	2.70	1×10^{-3}	2.70×10^{-2}	2.0×10^{1}	5.4×10^{2}
Cf-253		40	1080	6×10^{-2}	1.62	1.1×10^{3}	2.9×10^{4}
Cf-254		3×10^{-3}	8.11×10^{-2}	6×10^{-4}	1.62×10^{-2}	3.1×10^{2}	8.5×10^{3}
Cl-36	Chlorine (17)	20	541	0.5	13.5	1.2×10^{-3}	3.3×10^{-2}
Cl-38		0.2	5.41	0.2	5.41	4.9×10^{6}	1.3×10^{8}
Cm-240	Curium(96)	40	1080	2×10^{-2}	0.541	7.5×10^{2}	2.0×10^{4}
Cm-241		2	54.1	0.9	24.3	6.1×10^{2}	1.7×10^{4}
Cm-242		40	1080	1×10^{-2}	0.270	1.2×10^{2}	3.3×10^{3}
Cm-243		3	81.1	3×10^{-4}	8.11×10^{-3}	1.9	5.2×10^{1}
Cm-244		4	1080	4×10^{-4}	1.08×10^{-2}	3.0	8.1×10^{5}
Cm-245		2	54.1	2×10^{-4}	5.41×10^{-3}	6.4×10^{-3}	1.7×10^{-1}
Cm-246		2	54.1	2×10^{-4}	5.41×10^{-3}	1.1×10^{-2}	3.1×10^{-1}
Cm-247		2	54.1	2×10^{-4}	5.41×10^{-3}	3.4×10^{-6}	9.3×10^{-5}
Cm-248		4×10^{-2}	1.08	5×10^{-5}	1.35×10^{-3}	1.6×10^{-4}	4.2×10^{-3}
Co-55	Cobalt(27)	0.5	13.5	0.5	13.5	1.1×10^{5}	3.1×10^{6}
Co-56		0.3	8.11	0.3	8.11	1.1×10^{3}	3.0×10^{4}
Co-57		8	216	8	216	3.1×10^{2}	8.4×10^{3}
Co-58m		40	1080	40	1080	2.2×10^{5}	5.9×10^{6}
Co-58		1	27.0	1	27.0	1.2×10^{3}	3.2×10^{4}
Co-60		0.4	10.8	0.4	10.8	4.2×10^{1}	1.1×10^{3}
Cr-51	Chromium(24)	30	811	30	811	3.4×10^{3}	9.2×10^{4}
Cs-129	Cesium(55)	4	108	4	108	2.8×10^{4}	7.6×10^{5}
Cs-131		40	1080	40	1080	3.8×10^{3}	1.0×10^{5}
Cs-132		1	27.0	1	27.0	5.7×10^{3}	1.5×10^{5}
Cs-134m		40	1080	9	243	3.0×10^{5}	8.0×10^{6}
Cs-134		0.6	16.2	0.5	13.5	4.8×10^{1}	1.3×10^{3}
Cs-135		40	1080	0.9	24.3	4.3×10^{-5}	1.2×10^{-3}
Cs-136		0.5	13.5	0.5	13.5	2.7×10^{3}	7.3×10^{4}
Cs-137		2	54.1	0.5	13.5	3.2	8.7×10^{1}
Cu-64	Copper(29)	5	135	0.9	24.3	1.4×10^{5}	3.9×10^{6}
Cu-67		9	243	0.9	24.3	2.8×10^{4}	7.6×10^{5}
Dy-159	Dysprosium(66)	20	541	20	541	2.1×10^{2}	5.7×10^{3}
Dy-165		0.6	16.2	0.5	13.5	3.0×10^{5}	8.2×10^{6}
Dy-166		0.3	8.11	0.3	8.11	8.6×10^{3}	2.3×10^{5}
Er-169	Erbium(68)	40	1080	0.9	24.3	3.1×10^{3}	8.3×10^{4}
Er-171		0.6	16.2	0.5	13.5	9.0×10^{4}	2.4×10^{6}
Es-253	Einsteinium(99)[a]	40	1080	5×10^{-1}	1.35		
Es-254		30	811	3×10^{-3}	8.11×10^{-2}		
Es-254m		0.6	16.2	0.4	10.8		
Es-255							
Eu-147	Europium(63)	2	54.1	2	54.1	1.4×10^{3}	3.7×10^{4}
Eu-148		0.5	13.5	0.5	13.5	6.0×10^{2}	1.6×10^{4}
Eu-149		20	541	20	541	3.5×10^{2}	9.4×10^{3}

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Eu-150		0.7	18.9	0.7	18.9	6.1×10^{4}	6.7×10^{6}
Eu-152m		0.6	16.2	0.5	13.5	8.2×10^{4}	2.2×10^{6}
Eu-152		0.9	24.3	0.9	24.3	6.5	1.8×10^{2}
Eu-154		0.8	21.6	0.5	13.5	9.8	2.6×10^{2}
Eu-155		20	541	2	54.1	1.8×10^{1}	4.9×10^{3}
Eu-156		0.6	16.2	0.5	13.5	2.0×10^{3}	5.5×10^{4}
F-18	Fluorine(9)	1	27.0	0.5	13.5	3.5×10^{5}	9.5×10^{7}
Fe-52	Iron(26)	0.2	5.41	0.2	5.41	2.7×10^{5}	7.3×10^{6}
Fe-55		40	1080	40	1080	8.8×10^{1}	2.4×10^{3}
Fe-59		0.8	21.6	0.8	21.6	1.8×10^{3}	3.0×10^{4}
Fe-60		40	1080	0.2	5.41	7.4×10^{-4}	2.0×10^{-2}
Fm-255	Fermium(100)[b]	40	1080	0.8	21.6		
Fm-257		40	1080	7×10^{-3}	1.89×10^{-3}		
Ga-67	Gallium(31)	6	162	6	162	2.2×10^{4}	6.0×10^{5}
Ga-68		0.3	8.11	0.3	8.11	1.5×10^{6}	4.1×10^{7}
Ga-72		0.4	10.8	0.4	10.8	1.1×10^{5}	3.1×10^{6}
Gd-146	Gadolinium(64)	0.4	10.8	0.4	10.8	6.9×10^{2}	1.9×10^{4}
Gd-148		3	81.1	3×10^{-4}	8.11×10^{-3}	6.7	2.9×10^{1}
Gd-153		10	270	5	135	1.3×10^{2}	3.5×10^{3}
Gd-159		4	108	0.5	13.5	3.9×10^{4}	1.1×10^{6}
Ge-68	Germanium(32)	0.3	8.11	0.3	8.11	2.6×10^{2}	7.1×10^{3}
Ge-71		40	1080	40	1080	5.8×10^{3}	1.6×10^{5}
Ge-77		0.3	8.11	0.3	8.11	1.3×10^{5}	3.6×10^{6}
H-3	Hydrogen(1)SeeT-Tritium.						
Hf-172	Hafnium(72)	0.5	13.5	0.3	8.11	4.1×10^{1}	1.1×10^{3}
Hf-175		3	81.1	3	81.1	3.9×10^{2}	1.1×10^{4}
Hf-181		2	54.1	0.9	24.3	6.3×10^{2}	1.7×10^{4}
Hf-182		4	108	3×10^{-2}	0.811	8.1×10^{-6}	2.2×10^{-4}
Hg-194	Mercury(80)	1	27.0	1	27.0	1.3×10^{-1}	3.5
Hg-195m		5	135	5	135	1.5×10^{4}	4.0×10^{5}
Hg-197m		10	270	0.9	24.3	2.5×10^{4}	6.7×10^{5}
Hg-197		10	270	10	270	9.2×10^{3}	2.5×10^{5}
Hg-203		4	108	0.9	24.3	5.1×10^{2}	1.4×10^{4}
Ho-163	Holmium(67)	40	1080	40	1080	2.7	7.6×10^{1}
Ho-166m		0.6	16.2	0.3	8.11	6.6×10^{-2}	1.8
Ho-166		0.3	8.11	0.3	8.11	2.6×10^{4}	7.0×10^{5}
I-123	Iodine(53)	6	162	6	162	7.1×10^{4}	1.9×10^{6}
I-124		0.9	24.3	0.9	24.3	9.3×10^{3}	2.5×10^{5}
I-125		20	541	2	54.1	6.4×10^{2}	1.7×10^{4}
I-126		2	54.1	0.9	24.3	2.9×10^{3}	8.0×10^{4}
I-129		Unlimited	Unlimited	Unlimited	Unlimited	6.5×10^{-6}	1.8×10^{-4}
I-131		3	81.1	0.5	13.5	4.6×10^{3}	1.2×10^{5}
I-132		0.4	10.8	0.4	10.8	3.8×10^{5}	1.0×10^{7}
I-133		0.6	16.2	0.5	13.5	4.2×10^{4}	1.1×10^{6}
I-134		0.3	8.11	0.3	8.11	9.9×10^{5}	2.7×10^{7}
I-135		0.6	16.2	0.5	13.5	1.3×10^{5}	3.5×10^{6}
In-111	Indium(49)	2	54.1	2	54.1	1.5×10^{4}	4.2×10^{5}
In-113m		4	108	4	108	6.2×10^{5}	1.7×10^{7}
In-114m		0.3	8.11	0.3	8.11	8.6×10^{2}	2.3×10^{4}
In-115m		6	162	0.9	24.3	2.2×10^{5}	6.1×10^{6}
Ir-189	Iridium(77)	10	270	10	270	1.9×10^{3}	5.2×10^{4}
Ir-190		0.7	18.9	0.7	18.9	2.3×10^{3}	6.2×10^{4}
Ir-192		1	27.0	0.5	13.5	3.4×10^{2}	9.2×10^{3}
Ir-193m		10	270	10	270	2.4×10^{3}	6.4×10^{4}
Ir-194		0.2	5.41	0.2	5.41	3.1×10^{4}	8.4×10^{5}
K-40	Potassium(19)	0.6	16.2	0.6	16.2	2.4×10^{-7}	6.4×10^{-6}
K-42		0.2	5.41	0.2	5.41	2.2×10^{5}	6.0×10^{6}
K-43		1.0	27.0	0.5	13.5	1.2×10^{5}	3.3×10^{6}
Kr-81	Krypton(36)	40	1080	40	1080	7.8×10^{-4}	2.1×10^{-2}
Kr-85m		6	162	6	162	3.0×10^{5}	8.2×10^{6}
Kr-85		20	541	10	270	1.5×10^{1}	3.9×10^{2}
Kr-87		0.2	5.41	0.2	5.41	1.0×10^{6}	2.8×10^{7}
La-137	Lanthanum(57)	40	1080	2	54.1	1.6×10^{-3}	4.4×10^{-2}
La-140		0.4	10.8	0.4	10.8	2.1×10^{4}	5.6×10^{5}
Lu-172	Lutetium(71)	0.5	13.5	0.5	13.5	4.2×10^{3}	1.1×10^{5}
Lu-173		8	216	8	216	5.6×10^{1}	1.5×10^{3}
Lu-174m		20	541	8	216	2.0×10^{2}	5.3×10^{3}
Lu-74		8	216	4	108	2.3×10^{1}	6.2×10^{2}
Lu-177		30	811	0.9	24.3	4.1×10^{3}	1.1×10^{5}
Mg-28	Magnesium(12)	0.2	5.41	0.2	5.41	2.0×10^{5}	5.4×10^{6}
Mn-52	Manganese(25)	0.3	8.11	0.3	8.11	1.6×10^{4}	4.4×10^{5}

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Mn-53		Unlimited	Unlimited	Unlimited	Unlimited	6.8×10^{-5}	1.8×10^{-3}
Mn-54		1	27.0	1	27.0	2.9×10^{2}	7.7×10^{3}
Mn-56		0.2	5.41	0.2	5.41	8.0×10^{5}	2.2×10^{7}
Mo-93	Molybdenum(42) .	40	1080	7	189	4.1×10^{-2}	1.1
Mo-99		0.6	16.2	0.5	13.5[c]	1.8×10^{4}	4.8×10^{5}
N-13	Nitrogen(7)	0.6	16.2	0.5	13.5	5.4×10^{7}	1.5×10^{9}
Na-22	Sodium(11)	0.5	13.5	0.5	13.5	2.3×10^{2}	6.3×10^{3}
Na-24		0.2	5.41	0.2	5.41	3.2×10^{5}	8.7×10^{6}
Nb-92m	Niobium(41)	0.7	18.9	0.7	18.9	5.2×10^{3}	1.4×10^{5}
Nb-93m		40	1080	6	162	8.8	2.4×10^{2}
Nb-94		0.6	16.2	0.6	16.2	6.9×10^{-3}	1.9×10^{-1}
Nb-95		1	27.0	1	27.0	1.5×10^{3}	3.9×10^{4}
Nb-97		0.6	16.2	0.5	13.5	9.9×10^{5}	2.7×10^{7}
Nd-147	Neodymium(60)	4	108	0.5	13.5	3.0×10^{3}	8.1×10^{4}
Nd-149		0.6	16.2	0.5	13.5	4.5×10^{5}	1.2×10^{7}
Ni-59	Nickel(28)	40	1080	40	1080	3.0×10^{-3}	8.0×10^{-2}
Ni-63		40	1080	30	811	2.1	5.7×10^{1}
Ni-65		0.3	8.11	0.3	8.11	7.1×10^{5}	1.9×10^{7}
Np-235	Neptunium(93)	40	1080	40	1080	5.2×10^{1}	1.4×10^{3}
Np-236		7	189	1×10^{-3}	2.70×10^{-2}	4.7×10^{-4}	1.3×10^{-2}
Np-237		2	54.1	2×10^{-4}	5.41×10^{-3}	2.6×10^{-5}	7.1×10^{-4}
Np-239		6	162	0.5	13.5	8.6×10^{3}	2.3×10^{5}
Os-185	Osmium(76)	1	27.0	1	27.0	2.8×10^{2}	7.5×10^{3}
Os-191m		40	1080	40	1080	4.6×10^{4}	1.3×10^{6}
Os-191		10	270	0.9	24.3	1.6×10^{3}	4.4×10^{4}
Os-193		0.6	16.2	0.5	13.5	2.0×10^{4}	5.3×10^{5}
Os-194		0.2	5.41	0.2	5.41	1.1×10^{1}	3.1×10^{2}
P-32	Phosphorus(15)	0.3	8.11	0.3	8.11	1.1×10^{4}	2.9×10^{5}
P-33		40	1080	0.9	24.3	5.8×10^{3}	1.6×10^{5}
Pa-230	Protactinium(91)	2	54.1	0.1	2.70	1.2×10^{3}	3.3×10^{4}
Pa-231		0.6	16.2	6×10−5	1.62×10^{-3}	1.7×10^{-3}	4.7×10^{-2}
Pa-233		5	135	0.9	24.3	7.7×10^{2}	2.1×10^{4}
Pb-201	Lead(82)	1	27.0	1	27.0	6.2×10^{4}	1.7×10^{6}
Pb-202		40	1080	2	54.1	1.2×10^{-4}	3.4×10^{-3}
Pb-203		3	81.1	3	81.1	1.1×10^{4}	3.0×10^{5}
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	4.5×10^{-6}	1.2×10^{-4}
Pb-210		0.6	16.2	9×10^{-3}	0.243	2.8	7.6×10^{1}
Pb-212		0.3	8.11	0.3	8.11	5.1×10^{4}	1.4×10^{6}
Pd-103	Palladium(46)	40	1080	40	1080	2.8×10^{3}	7.5×10^{4}
Pd-107	Unlimited	Unlimited	Unlimited	Unlimited	1.9×10^{-5}	5.1×10^{-4}	
Pd-109		0.6	16.2	0.5	13.5	7.9×10^{4}	2.1×10^{6}
Pm-143	Promethium(61)	3	81.1	3	81.1	1.3×10^{2}	3.4×10^{3}
Pm-144		0.6	16.2	0.6	16.2	9.2×10^{1}	2.5×10^{3}
Pm-145		30	811	7	189	5.2	1.4×10^{2}
Pm-147		40	1080	0.9	24.3	3.4×10^{1}	9.3×10^{2}
Pm-148m		0.5	13.5	0.5	13.5	7.9×10^{2}	2.1×10^{4}
Pm-149		0.6	16.2	0.5	13.5	1.5×10^{4}	4.0×10^{5}
Pm-151		3	81.1	0.5	13.5	2.7×10^{4}	7.3×10^{5}
Po-208	Polonium(84)	40	1080	2×10^{-2}	0.541	2.2×10^{1}	5.9×10^{2}
Po-209		40	1080	2×10^{-2}	0.541	6.2×10^{-1}	1.7×10^{1}
Po-210		40	1080	2×10^{-2}	0.541	1.7×10^{2}	4.5×10^{3}
Pr-142	Praseodymium (59).	0.2	5.41	0.2	5.41	4.3×10^{4}	1.2×10^{6}
Pr-143		4	108	0.5	13.5	2.5×10^{3}	6.7×10^{4}
Pt-188	Platinum(78)	0.6	16.2	0.6	16.2	2.5×10^{3}	6.8×10^{4}
Pt-191		3	81.1	3	81.1	8.7×10^{3}	2.4×10^{5}
Pt-193m		40	1080	9	243	5.8×10^{3}	1.6×10^{5}
Pt-193		40	1080	40	1080	1.4	3.7×10^{1}
Pt-195m		10	270	2	54.1	6.2×10^{3}	1.7×10^{5}
Pt-197m		10	270	0.9	24.3	3.4×10^{5}	1.0×10^{7}
Pt-197		20	541	0.5	13.5	3.2×10^{4}	8.7×10^{5}
Pu-236	Plutonium(94)	7	189	7×10^{-4}	1.89×10^{-2}	2.0×10^{1}	5.3×10^{2}
Pu-237		20	541	20	541	4.5×10^{2}	1.2×10^{4}
Pu-238		2	54.1	2×10^{-4}	5.41×10^{-3}	6.3×10^{-1}	1.7×10^{1}
Pu-239		2	54.1	2×10^{-4}	5.41×10^{-3}	2.3×10^{-3}	6.2×10^{-2}
Pu-240		2	54.1	2×10^{-4}	5.41×10^{-3}	8.4×10^{-3}	2.3×10^{-1}
Pu-241		40	1080	1×10^{-2}	0.270	3.8	1.0×10^{2}
Pu-242		2	54.1	2×10^{-4}	5.41×10^{-3}	1.5×10^{-4}	3.9×10^{-3}
Pu-244		0.3	8.11	2×10^{-4}	5.41×10^{-3}	6.7×10^{-7}	1.8×10^{-5}
Ra-223	Radium(88)	0.6	16.2	3×10^{-2}	0.811	1.9×10^{3}	5.1×10^{4}
Ra-224		0.3	8.11	6×10^{-2}	1.62	5.9×10^{3}	1.6×10^{5}
Ra-225		0.6	16.2	2×10^{-2}	0.541	1.5×10^{3}	3.9×10^{4}

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Ra-226		0.3	8.11	2×10^{-2}	0.541	3.7×10^{-2}	1.0
Ra-228		0.6	16.2	4×10^{-2}	1.08	1.0×10^{1}	2.7×10^{2}
Rb-81	Rubidium(37)	2	54.1	0.9	24.3	3.1×10^{5}	8.4×10^{6}
Rb-83		2	54.1	2	54.1	6.8×10^{2}	1.8×10^{4}
Rb-84		1	27.0	0.9	24.3	1.8×10^{3}	4.7×10^{4}
Rb-86		0.3	8.11	0.3	8.11	3.0×10^{3}	8.1×10^{4}
Rb-87		Unlimited	Unlimited	Unlimited	Unlimited	3.2×10^{-9}	8.6×10^{-8}
Rb (natural)		Unlimited	Unlimited	Unlimited	Unlimited	6.7×10^{6}	1.8×10^{8}
Re-183	Rhenium(75)	5	135	5	135	3.8×10^{2}	1.0×10^{4}
Re-184m		3	81.1	3	81.1	1.6×10^{2}	4.3×10^{3}
Re-184		1	27.0	1	27.0	6.9×10^{2}	1.9×10^{4}
Re-186		4	108	0.5	13.5	6.9×10^{3}	1.9×10^{5}
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	1.4×10^{-9}	3.8×10^{-8}
Re-188		0.2	5.41	0.2	5.41	3.6×10^{4}	9.8×10^{5}
Re-189		4	108	0.5	13.5	2.5×10^{4}	6.8×10^{5}
Re (natural)		Unlimited	Unlimited	Unlimited	Unlimited	———	2.4×10^{8}
Rh-99	Rhodium(45)	2	54.1	2	54.1	3.0×10^{3}	8.2×10^{4}
Rh-101		4	108	4	108	4.1×10^{1}	1.1×10^{3}
Rh-102m		2	54.1	0.9	24.3	2.3×10^{2}	6.2×10^{3}
Rh-102		0.5	13.5	0.5	13.5	4.5×10^{1}	1.2×10^{3}
Rh-103m		40	1080	40	1080	1.2×10^{6}	3.3×10^{7}
Rh-105		10	270	0.9	24.3	3.1×10^{4}	8.4×10^{5}
Rn-222	Radon(86)	0.2	5.41	4×10^{3}	0.108	5.7×10^{3}	1.5×10^{5}
Ru-97	Ruthenium(44)	4	108	4	108	1.7×10^{4}	4.6×10^{5}
Ru-103		2	54.1	0.9	24.3	1.2×10^{3}	3.2×10^{4}
Ru-105		0.6	16.2	0.5	13.5	2.5×10^{5}	6.7×10^{6}
Ru-106		0.2	5.41	0.2	5.41	1.2×10^{2}	3.3×10^{3}
S-35	Sulfur(16)	40	1080	2	54.1	1.6×10^{3}	4.3×10^{4}
Sb-122	Antimony(51)	0.3	8.11	0.3	8.11	1.5×10^{4}	4.0×10^{5}
Sb-124		0.6	16.2	0.5	13.5	6.5×10^{2}	1.7×10^{4}
Sb-125		2	54.1	0.9	24.3	3.9×10^{1}	1.0×10^{3}
Sb-126		0.4	10.8	0.4	10.8	3.1×10^{3}	8.4×10^{4}
Sc-44	Scandium(21)	0.5	13.5	0.5	13.5	6.7×10^{5}	1.8×10^{7}
Sc-46		0.5	13.5	0.5	13.5	1.3×10^{3}	3.4×10^{4}
Sc-47		9	243	0.9	24.3	3.1×10^{4}	8.3×10^{5}
Sc-48		0.3	8.11	0.3	8.11	5.5×10^{4}	1.5×10^{6}
Se-75	Selenium(34)	3	81.1	3	81.1	5.4×10^{2}	1.5×10^{4}
Se-79		40	1080	2	54.1	2.6×10^{-3}	7.0×10^{-2}
Si-31	Silicon(14)	0.6	16.2	0.5	13.5	1.4×10^{6}	3.9×10^{7}
Si-32		40	10800	0.2	5.41	3.9	1.1×10^{2}
Sm-145	Samarium(62)	20	541	20	541	9.8×10^{1}	2.610^{3}
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	$8.510-10$	$2.310-8$
Sm-151		40	1080	4	108	$9.710-1$	2.6×10^{1}
Sm-153		4	108	0.5	13.5	1.6×10^{4}	4.4×10^{5}
Sn-113	Tin(50)	4	108	4	108	3.7×10^{2}	1.0×10^{4}
Sn-117m		6	162	2	54.1	3.0×10^{3}	8.2×10^{4}
Sn-119m		40	1080	40	1080	1.4×10^{2}	3.7×10^{3}
Sn-121m		40	1080	0.9	24.3	2.0	5.4×10^{1}
Sn-123		0.6	16.2	0.5	13.5	3.0×10^{2}	8.2×10^{3}
Sn-125		0.2	5.41	0.2	5.41	4.0×10^{3}	1.1×10^{5}
Sn-126		0.3	8.11	0.3	8.11	$1.010-3$	$2.810-2$
Sr-82	Strontium(38)	0.2	5.41	0.2	5.41	2.3×10^{3}	6.2×10^{4}
Sr-85m		5	135	5	135	1.2×10^{6}	3.3×10^{7}
Sr-85		2	54.1	2	54.1	8.8×10^{2}	2.4×10^{4}
Sr-87m		3	81.1	3	81.1	4.8×10^{5}	1.3×10^{7}
Sr-89		0.6	16.2	0.5	13.5	1.1×10^{3}	2.9×10^{4}
Sr-90		0.2	5.41	0.1	2.70	5.1	1.4×10^{2}
Sr-91		0.3	8.11	0.3	8.11	1.3×10^{5}	3.6×10^{6}
Sr-92		0.8	21.6	0.5	13.5	4.7×10^{5}	1.3×10^{7}
T	Tritium(1)	40	1080	40	1080	3.6×10^{2}	9.7×10^{3}
Ta-178	Tantalum(73)	1	27.0	1	27.0	4.2×10^{6}	1.1×10^{8}
Ta-179		30	811	30	811	4.1×10^{1}	1.1×10^{3}
Ta-182		0.8	21.6	0.5	13.5	2.3×10^{2}	6.2×10^{3}
Tb-157	Terbium(65)	40	1080	10	270	$5.610-1$	1.5×10^{1}
Tb-158		1	27.0	0.7	18.9	$5.610-1$	1.5×10^{1}
Tb-160		0.9	24.3	0.5	13.5	4.2×10^{2}	1.1×10^{4}
Tc-95m	Technetium(43)	2	54.1	2	54.1	8.3×10^{2}	2.2×10^{4}
Tc-96m		0.4	10.8	0.4	10.8	1.4×10^{6}	3.8×10^{7}
Tc-96		0.4	10.8	0.4	10.8	1.2×10^{4}	3.2×10^{5}
Tc-97m		40	1080	40	1080	5.6×10^{2}	1.5×10^{4}
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	5.2×10^{-5}	1.4×10^{-3}
Tc-98		0.7	18.9	0.7	18.9	3.2×10^{-5}	8.7×10^{-4}

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Tc-99m		8	216	8	216	1.9×10^{5}	5.3×10^{6}
Tc-99		40	1080	0.9	24.3	6.3×10^{-4}	1.7×10^{-2}
Te-118	Tellurium(52)	0.2	5.41	0.2	5.41	6.8×10^{3}	1.8×10^{5}
Te-121m		5	135	5	135	2.6×10^{2}	7.0×10^{3}
Te-121		2	54.1	2	54.1	2.4×10^{3}	6.4×10^{4}
Te-123m		7	189	7	189	3.3×10^{2}	8.9×10^{3}
Te-125m		30	811	9	243	6.7×10^{2}	1.8×10^{4}
Te-127m		20	541	0.5	13.5	3.5×10^{2}	9.4×10^{3}
Te-127		20	541	0.5	13.5	9.8×10^{4}	2.6×10^{6}
Te-129m		0.6	16.2	0.5	13.5	1.1×10^{3}	3.0×10^{4}
Te-129		0.6	16.2	0.5	13.5	7.7×10^{5}	2.1×10^{7}
Te-131m		0.7	18.9	0.5	13.5	3.0×10^{4}	8.0×10^{5}
Te-132		0.4	10.8	0.4	10.8	1.1×10^{4}	3.0×10^{5}
Th-227	Thorium(90)	9	243	1×10^{-2}	0.270	1.1×10^{3}	3.1×10^{4}
Th-228		0.3	8.11	4×10^{-4}	1.08×10^{-2}	3.0×10^{1}	8.2×10^{2}
Th-229		0.3	8.11	3×10^{-5}	8.11×10^{-4}	7.9×10^{-3}	2.1×10^{-1}
Th-230		2	54.1	2×10^{-4}	5.41×10^{-3}	7.6×10^{-4}	2.1×10^{-2}
Th-231		40	1080	0.9	24.3	2.0×10^{4}	5.3×10^{5}
Th-232		Unlimited	Unlimited	Unlimited	Unlimited	4.0×10^{-9}	1.1×10^{-7}
Th-234		0.2	5.41	0.2	5.41	8.6×10^{2}	2.3×10^{4}
Th (natural)		Unlimited	Unlimited	Unlimited	Unlimited	8.1×10^{-9}	2.2×10^{-7}
Ti-44	Titanium(22)	0.5	13.5	0.2	5.41	6.4	1.7×10^{2}
Tl-200	Thallium(81.1)	0.8	21.6	0.8	21.6	2.2×10^{4}	6.0×10^{5}
Tl-201		10	270	10	270	7.9×10^{3}	2.1×10^{5}
Tl-202		2	54.1	2	54.1	2.0×10^{3}	5.3×10^{4}
Tl-204		4	108	0.5	13.5	1.7×10^{1}	4.6×10^{2}
Tm-167	Thulium(69)	7	189	7	189	3.1×10^{3}	8.5×10^{4}
Tm-168		0.8	21.6	0.8	21.6	3.1×10^{2}	8.3×10^{3}
Tm-170		4	108	0.5	13.5	2.2×10^{2}	6.0×10^{3}
Tm-171		40	1080	10	270	4.0×10^{1}	1.1×10^{3}
U-230	Uranium(92)	40	1080	1×10^{-2}	0.270	1.0×10^{3}	2.7×10^{4}
U-232		3	81.1	3×10^{-4}	8.11×10^{-3}	8.3×10^{-1}	2.2×10^{1}
U-233		10	270	1×10^{-3}	2.70×10^{-2}	3.6×10^{-4}	9.7×10^{-3}
U-234		10	270	1×10^{-3}	2.70×10^{-2}	2.3×10^{-4}	6.2×10^{-3}
U-235		Unlimited	Unlimited	Unlimited	Unlimited	8.0×10^{-8}	2.2×10^{-6}
U-236		10	270	1×10^{-3}	2.70×10^{-2}	2.4×10^{-6}	6.5×10^{-5}
U-238		Unlimited	Unlimited	Unlimited	Unlimited	1.2×10^{-8}	3.4×10^{-7}
U (natural)		Unlimited	Unlimited	Unlimited	Unlimited	2.6×10^{-8}	7.1×10^{-7}
U (enriched 5% or less).		Unlimited	Unlimited	Unlimited	Unlimited	———	(see § 173.434)
U (enriched more than 5%).		10	270	1×10^{-3}	2.70×10^{-2}	———	(see § 173.434)
U (depleted)		Unlimited	Unlimited	Unlimited	Unlimited	———	(see § 173.434)
V-48	Vanadium(23)	0.3	8.11	0.3	8.11	6.3×10^{3}	1.7×10^{5}
V-49		40	1080	40	1080	3.0×10^{2}	8.1×10^{3}
W-178	Tungsten(74)	1	27.0	1	27.0	1.3×10^{-3}	3.4×10^{4}
W-181		30	811	30	811	2.2×10^{2}	6.0×10^{3}
W-185		40	1080	0.9	24.3	3.5×10^{2}	9.4×10^{3}
W-187		2	54.1	0.5	13.5	2.6×10^{4}	7.0×10^{5}
W-188		0.2	5.41	0.2	5.41	3.7×10^{2}	1.0×10^{4}
Xe-122	Xenon(54)	0.2	5.41	0.2	5.41	4.8×10^{4}	1.3×10^{6}
Xe-123		0.2	5.41	0.2	5.41	4.4×10^{5}	1.2×10^{7}
Xe-127		4	108	4	108	1.0×10^{3}	2.8×10^{4}
Xe-131m		40	1080	40	1080	3.1×10^{3}	8.4×10^{4}
Xe-133		20	541	20	541	6.9×10^{3}	1.9×10^{5}
Xe-135		4	108	4	108	9.5×10^{4}	2.6×10^{6}
Y-87	Yttrium(39)	2	54.1	2	54.1	1.7×10^{4}	4.5×10^{5}
Y-88		0.4	10.8	0.4	10.8	5.2×10^{2}	1.4×10^{4}
Y-90		0.2	5.41	0.2	5.41	2.0×10^{4}	5.4×10^{5}
Y-91m		2	54.1	2	54.1	1.5×10^{6}	4.2×10^{7}
Y-91		0.3	8.11	0.3	8.11	9.1×10^{2}	2.5×10^{4}
Y-92		0.2	5.41	0.2	5.41	3.6×10^{5}	9.6×10^{6}
Y-93		0.2	5.41	0.2	5.41	1.2×10^{5}	3.3×10^{6}
Yb-169	Ytterbium(70)	3	81.1	3	81.1	8.9×10^{2}	2.4×10^{4}
Yb-175		30	811	0.9	24.3	6.6×10^{3}	1.8×10^{5}
Zn-65	Zinc(30)	2	54.1	2	54.1	3.0×10^{2}	8.2×10^{3}
Zn-69m		2	54.1	0.5	13.5	1.2×10^{5}	3.3×10^{6}
Zn-69		4	108	0.5	13.5	1.8×10^{6}	4.9×10^{7}
Zr-88	Zirconium(40)	3	81.1	3	81.1	6.6×10^{2}	1.8×10^{4}
Zr-93		40	1080	0.2	5.41	9.3×10^{-5}	2.5×10^{-3}
Zr-95		1	27.0	0.9	24.3	7.9×10^{2}	2.1×10^{4}

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Zr-97		0.3	8.11	0.3	8.11	7.1×10^{4}	1.9×10^{6}

[a] International shipments of Einsteinium require multilateral approval of A_1 and A_2 values.
[b] International shipments of Fermium require multilateral approval of A_1 and A_2 values.
[c] 20 Ci for Mo^{99} for domestic use.
MFP: For mixed fission products, use formula for mixtures or Table 10 in § 173.433.
Note: The activity per gram of radionuclide quantities are technical information that might not provide a direct relationship between the activity and total mass of material contained in a package.

§ 173.441 Radiation level limitations.

(a) Except as provided in paragraph (b) of this section, each package of Class 7 (radioactive) materials offered for transportation must be designed and prepared for shipment, so that under conditions normally incident to transportation, the radiation level does not exceed 2 mSv/hour (200 mrem/hour) at any point on the external surface of the package, and the transport index does not exceed 10.

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

(1) 2 mSv/h (200 mrem/h) on the external surface of the package unless the following conditions are met, in which case the limit is 10 mSv/h (1000 mrem/h):

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

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

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

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

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

(4) 0.02 mSv/h (2 mrem/h) in any normally occupied space, except that this provision does not apply to private carriers if exposed personnel under their control wear radiation dosimetry devices as part of a radiation protection program that satisfies the requirements of subpart I of part 172 of this subchapter.

(c) For shipments made under the provisions of paragraph (b) of this section, the offeror shall provide specific written instructions for maintenance of the exclusive use shipment controls to the carrier. The instructions must be included with the shipping paper information. The instructions must be sufficient so that, when followed, they will cause the carrier to avoid actions that will unnecessarily delay delivery or unnecessarily result in increased radiation levels or radiation exposures to transport workers or members of the general public.

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

§ 173.442 Thermal limitations.

A package of Class 7 (radioactive) material must be designed, constructed, and loaded so that—

(a) The heat generated within the package by the radioactive contents will not, during conditions normally incident to transport, affect the integrity of the package; and

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

(1) 50°C (122°F) in other than an exclusive use shipment; or

(2) 85°C (185°F) in an exclusive use shipment.

§ 173.443 Contamination control.

(a) The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for transport must be kept as low as reasonably achievable. The level of non-fixed radioactive contamination may not exceed the limits set forth in Table 11 and must be determined by either:

(1) 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. The amount of radioactivity measured on any single wiping material, when averaged over the surface wiped, may not exceed the limits set forth in Table 11 at any time during transport; or

(2) Using other methods of assessment of equal or greater efficiency, in which case the efficiency of the method used must be taken into account and the non-fixed contamination on the external surfaces of the package may not exceed ten times the limits set forth in Table 11, as follows:

TABLE 11.—NON-FIXED EXTERNAL RADIOACTIVE CONTAMINATION-WIPE LIMITS

Contaminant	Maximum permissible limits		
	Bq/cm²	uCi/cm²	dpm/cm²
Beta and gamma emitters and low toxicity alpha emitters	0.41	0^{-5}	22
All other alpha emitting radionuclides	0.04	10^{-6}	2.2

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

(c) Except as provided in paragraph (d) of this section, each transport vehicle used for transporting Class 7 (radioactive) materials as an exclusive use shipment that utilizes the

provisions of paragraph (b) of this section must be surveyed with appropriate radiation detection instruments after each use. A vehicle may not be returned to service until the radiation dose rate at each accessible surface is 0.005 mSv per hour (0.5 mrem per hour) or less, and there is no significant removable (non-fixed) radioactive surface contamination as specified in paragraph (a) of this section.

(d) Paragraphs (b) and (c) of this section do not apply to any closed transport vehicle used solely for the transportation by highway or rail of Class 7 (radioactive) material packages with contamination levels that do not exceed 10 times the levels prescribed in paragraph (a) of this section if—

(1) A survey of the interior surfaces of the empty vehicle shows that the radiation dose rate at any point does not exceed 0.1 mSv per hour (10 mrem per hour) at the surface or 0.02 mSv per hour (2 mrem per hour) at 1 meter (3.3 feet) from the surface;

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

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

§ 173.444 Labeling requirements.

Each package of Class 7 (radioactive) materials, unless excepted by § 173.421, § 173.424, § 173.426, 173.427 or § 173.428, must be labeled as prescribed in Subpart E of Part 172 of this subchapter.

§ 173.446 Placarding requirements.

Placarding requirements are prescribed in Subpart F of Part 172 of this subchapter.

§ 173.447 Storage incident to transportation—general requirements.

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

(a) The number of packages bearing RADIOACTIVE YELLOW-II or RADIOACTIVE YELLOW-III labels stored in any one storage area, such as a transit area, terminal building, storeroom, waterfront pier, or assembly yard, must be limited so that the sum of the transport indexes in any individual group of packages does not exceed 50. Groups of these packages must be stored so as to maintain a spacing of at least 6 meters (20 feet) from other groups of packages containing Class 7 (radioactive) materials.

(b) Mixing of different kinds of Class 7 (radioactive) materials packages that include fissile materials packages is authorized only in accordance with § 173.459.

§ 173.448 General transportation requirements.

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

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

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

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

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

(d) Mixing of different kinds of packages that include fissile packages is authorized only in accordance with § 173.459.

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

(f) No person shall offer for transportation or transport aboard a passenger-carrying aircraft any Class 7 (radioactive) material unless that material is intended for use in, or incident to, research, medical diagnosis or treatment.

(g) If an overpack is used to consolidate individual packages of Class 7 (radioactive) materials, the packages must comply with the packaging, marking, and labeling requirements of this subchapter, and the following:

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

(i) The ''contents'' entry on the label may state ''mixed'' unless each inside package contains the same radionuclide(s);

(ii) The ''activity'' entry on the label must be determined by adding together the number of Becquerels (curies) of the Class 7 (radioactive) materials packages contained therein;

(iii) For a non-rigid overpack, the required label together with required package markings must be affixed to the overpack by means of a securely attached, durable tag. The transport index must be determined by adding together the transport indexes of the Class 7 (radioactive) materials packages contained therein; and

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

(A) Adding together the transport indexes of the Class 7 (radioactive) materials packages contained in the overpack; or

(B) Except for fissile Class 7 (radioactive) materials, direct measurements as prescribed in § 173.403 for transport index, taken by the person initially offering the packages contained within the overpack for shipment.

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

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

§ 173.451 Fissile materials—general requirements.

Except as provided in § 173.453, each package containing fissile Class 7 (radioactive) materials must comply with §§ 173.457 and 173.459.

§ 173.453 Fissile materials—exceptions.

The requirements of §§ 173.451 through 173.459 do not apply to:

(a) A package containing 15 grams or less of fissile radionuclides. If the material is transported in bulk, the quantity limitation applies to the conveyance.

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

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

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

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

(c) A package containing uranium enriched in uranium-235 to a maximum of 1% by mass, and mixed with a total plutonium and uranium-233 content of up to 1% of the mass of uranium-235, if the fissile radionuclides are distributed homogeneously throughout the package contents, and do not form a lattice arrangement within the package.

(d) A package containing not more than 5 grams of fissile radionuclides in any 10 liter volume, provided that the material is contained in packages that will maintain the limitation on fissile radionuclide distribution during normal conditions of transport.

(e) A package containing one kilogram or less of plutonium of which 20% or less by mass may consist of plutonium-239, plutonium-241, or any combination of those radionuclides.

(f) A package containing liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with total plutonium and uranium-233 content not exceeding 0.1% of the mass of uranium-235 with a nitrogen-to-uranium atomic ratio (N/U) of 2.

§ 173.457 Transportation of fissile material, controlled shipments—specific requirements.

Shipments of fissile material packages that have been assigned a transport index of greater than 10 for criticality control purposes in accordance with 10 CFR 71.59 must meet the requirements of this section and § 173.441(a) or (b).

(a) For fissile material, controlled shipments, the offeror or carrier, as appropriate, must incorporate transportation controls which:

(1) Provide nuclear criticality safety;

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

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

(b) Fissile material, controlled shipments must be transported:

(1) In an exclusive use conveyance;

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

(3) In a conveyance containing no other packages of any Class 7 (radioactive) material required to bear one of the labels prescribed in § 172.403 of this subchapter. Specific arrangements must be made between the offeror and the carrier, with instructions to that effect issued with the shipping papers; or

(4) Under any other procedure approved by the Associate Administrator for Hazardous Materials Safety in accordance with Part 107 of this subchapter.

§ 173.459 Mixing of fissile material packages.

(a) Mixing of fissile material packages with other types of Class 7 (radioactive) materials is authorized only if the transport index of any single package does not exceed 10 and the total transport index in any conveyance or storage location does not exceed 50.

(b) Fissile packages may be shipped with an external radiation level greater than 0.1 mSv/hr (10 mrem per hour) at 1 meter (3.3 feet), and combined with other packages of the same or different designs in a fissile material, controlled shipment, under the conditions prescribed in § 173.457, if:

(1) Each package in the shipment has been assigned a transport index for criticality control purposes in accordance with the 10 CFR 71.59;

(2) The nuclear criticality control transport index does not exceed 10 for any single package;

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

(4) Except as provided in § 176.704(e) of this subchapter, the shipment is not transported by vessel.

(c) A fissile material, controlled shipment of packages may be combined with other packages of the same or different design when each package has been assigned a nuclear criticality control transport index in accordance with 10 CFR 71.59, and may be combined with other fissile packages into a fissile material, controlled shipment under the conditions prescribed in § 173.457, if:

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

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

(3) Except as provided in § 176.704(e) of this subchapter, the shipment is not transported by vessel.

§ 173.461 Demonstration of compliance with tests.

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

(1) Performance of tests with prototypes or samples of the specimens representing LSA-III, special form Class 7 (radioactive) material, or packaging, in which case the contents of the packaging for the test must simulate as closely as practicable the expected range of physical properties of the radioactive contents or packaging to be tested, must be prepared as normally presented for transport. The use of non-radioactive substitute contents is encouraged provided that the results of the testing take into account the radioactive characteristics of the contents for which the package is being tested;

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

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

(4) Calculations or reasoned evaluation, using reliable and conservative procedures and parameters.

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

§ 173.462 Preparation of specimens for testing.

(a) Each specimen (i.e., sample, prototype or scale model) must be examined before testing to identify and record faults or damage, including:

(1) Divergence from the specifications or drawings;

(2) Defects in construction;

(3) Corrosion or other deterioration; and

(4) Distortion of features.

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

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

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

§ 173.463 Packaging and shielding—testing for integrity.

After each of the applicable tests specified in §§ 173.465 and 173.466, the

integrity of the packaging, or of the packaging and its shielding, whichever is applicable, must be retained to the extent required by § 173.412(j) for the packaging being tested.

§ 173.465 Type A packaging tests.

(a) The packaging, with contents, must be capable of withstanding the water spray, free drop, compression and penetration tests prescribed in this section. One prototype may be used for all tests if the requirements of paragraph (b) of this section are met.

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

(c) *Free drop test.* The specimen must drop onto the target so as to suffer maximum damage to the safety features being tested, and:

(1) The height of the drop measured from the lowest point of the specimen to the upper surface of the target may not be less than the distance specified in Table 12, for the applicable package mass. The target must be as specified in § 173.465(c)(5). Table 12 is as follows:

TABLE 12.—FREE DROP DISTANCE FOR TESTING PACKAGES TO NORMAL CONDITIONS OF TRANSPORT

Packaging mass	Free drop distance	
Kilograms (pounds)	Meters	(Feet)
< Mass 5000 (11,000) ..	1.2	(4)
5,000 (11,000) Mass to 10,000 (22,000)	0.9	(3)
10,000 (22,000) Mass to 15,000 (33,000)	0.6	(2)
> 15,000 (33,000) Mass	0.3	(1)

(2) For packages containing fissile material, the free drop test specified in paragraph (c)(1) of this section must be preceded by a free drop from a height of 0.3 meter (1 foot) on each corner, or in the case of cylindrical packages, onto each of the quarters of each rim.

(3) For fiberboard or wood rectangular packages with a mass of 50 kilograms (110 pounds) or less, a separate specimen must be subjected to a free drop onto each corner from a height of 0.3 meter (1 foot).

(4) For cylindrical fiberboard packages with a mass of 100 kilograms (220 pounds) or less, a separate specimen must be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 meter (1 foot).

(5) The target for the free drop test must be a flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

(d) *Stacking test.* (1) The specimen must be subjected for a period of at least 24 hours to a compressive load equivalent to the greater of the following:

(i) Five times the mass of the actual package; or

(ii) The equivalent of 13 kilopascals (1.9 pounds per square inch) multiplied by the vertically projected area of the package.

(2) The compressive load must be applied uniformly to two opposite sides of the specimen, one of which must be the base on which the package would normally rest.

(e) *Penetration test.* For the penetration test, the specimen must be placed on a rigid, flat, horizontal surface that will not move significantly while the test is being performed.

(1) A bar of 3.2 centimeters (1.3 inches) in diameter with a hemispherical end and a mass of 6 kilograms (13.2 pounds) must be dropped and directed to fall with its longitudinal axis vertical, onto the center of the weakest part of the specimen, so that, if it penetrates far enough, it will hit the containment system. The bar may not be significantly deformed by the test; and

(2) The height of the drop of the bar measured from its lower end to the intended point of impact on the upper surface of the specimen must be 1 meter (3.3 feet) or greater.

§ 173.466 Additional tests for Type A packagings designed for liquids and gases.

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

(1) *Free drop test.* The packaging specimen must drop onto the target so as to suffer the maximum damage to its containment. The height of the drop measured from the lowest part of the packaging specimen to the upper surface of the target must be 9 meters (30 feet) or greater. The target must be as specified in § 173.465(c)(5).

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

§ 173.467 Tests for demonstrating the ability of Type B and fissile materials packagings to withstand accident conditions in transportation.

Each Type B packaging or packaging for fissile material must meet the test requirements prescribed in 10 CFR Part 71 for ability to withstand accident conditions in transportation.

§ 173.468 Test for LSA–III material.

(a) LSA–III Class 7 (radioactive) material must meet the test requirement of paragraph (b) of this section. Any differences between the material to be transported and the test material must be taken into account in determining whether the test requirements have been met.

(b) *Test method.* (1) The specimen representing no less than the entire contents of the package must be immersed for 7 days in water at ambient temperature.

(2) The volume of water to be used in the test must be sufficient to ensure that at the end of the test period the free volume of the unabsorbed and unreacted water remaining will be at least 10% of the volume of the specimen itself.

(3) The water must have an initial pH of 6–8 and a maximum conductivity of 10 micromho/cm at 20°C (68°F).

(4) The total activity of the free volume of water must be measured following the 7 day immersion test and must not exceed 0.1 A_2.

§ 173.469 Tests for special form Class 7 (radioactive) materials.

(a) Special form Class 7 (radioactive) materials must meet the test requirements of paragraph (b) of this section. Each solid Class 7 (radioactive) material or capsule specimen to be tested must be manufactured or fabricated so that it is representative of the actual solid material or capsule that will be transported with the proposed radioactive content duplicated as closely as practicable. Any differences between the material to be transported and the test material, such as the use of non-radioactive contents, must be taken into account in determining whether the test requirements have been met. The following additional conditions apply:

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

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

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

(4) After each test, leaktightness or indispersibility of the specimen must be determined by—

(i) A method no less sensitive than the leaching assessment prescribed in paragraph (c) of this section. For a capsule resistant to corrosion by water, and which has an internal void volume greater than 0.1 milliliter, an alternative to the leaching assessment is a demonstration of leaktightness of 10^{-4} torr-l/s (1.3×10^{-24} atm-cm^3/s) based on air at 25°C (77°F) and one atmosphere differential pressure for solid radioactive content, or 10^{-6} torr-l/s (1.3×10^{-6} atm-cm^3/s) for liquid or gaseous radioactive content; or

(ii) A specimen that comprises or simulates Class 7 (radioactive) material contained in a sealed capsule need not be subjected to the leaktightness procedure specified in this section provided it is alternatively subjected to any of the tests prescribed in ISO/TR4826–1979(E), ''Sealed Radioactive Sources Leak Test Methods.''

(b) *Test methods.*—(1) *Impact Test.* The specimen must fall onto the target from a height of 9 meters (30 feet) or greater. The target must be as specified in § 173.465(c)(5).

(2) *Percussion Test.* (i) The specimen must be placed on a sheet of lead that 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 drop of 1.4 kilograms (3 pounds) through 1 meter (3.3 feet).

(ii) The flat face of the billet must be 2.5 centimeters (1 inch) in diameter with the edges rounded off to a radius of 3 millimeters ±0.3 millimeters (0.12 inch ±0.012 inch).

(iii) The lead must be of hardness number 3.5 to 4.5 on the Vickers scale and thickness 2.5 centimeters (1 inch) or greater, and must cover an area greater than that covered by the specimen.

(iv) A fresh surface of lead must be used for each impact.

(v) The billet must strike the specimen so as to cause maximum damage.

(3) *Bending test.* (i) This test applies only to long, slender sources with a length of 10 centimeters (4 inches) or greater and a length to width ratio of 10 or greater.

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

(iii) 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.

(iv) The billet must strike the specimen so as to produce an impact equivalent to that resulting from a free vertical drop of 1.4 kilograms (3 pounds) through 1 meter (3.3 feet).

(v) The flat face of the billet must be 2.5 centimeters (1 inch) in diameter with the edges rounded off to a radius of 3 millimeters ±0.3 millimeters (.12 inch ±0.012 inch).

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

(c) *Leaching assessment methods.* (1) For indispersible solid material—

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

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

(iii) The activity of the water must then be determined.

(iv) The specimen must then be stored for at least seven days in still air of relative humidity not less than 90 percent at 30°C (86°F).

(v) The specimen must then be immersed in water under the same conditions as in paragraph (c)(1)(i) of this section, and the water with specimen must be heated to 50°C ±5 (122°F ±9°) and maintained at that temperature for four hours.

(vi) The activity of the water must then be determined. The activities determined in paragraph (c)(1)(iii) of this section and this paragraph, (c)(1)(vi), may not exceed 2 kilobecquerels (0.05 microcurie).

(2) For encapsulated material—

(i) The specimen must be immersed in water at ambient temperature. The water must have a pH of 6–8 and a maximum conductivity of 10 micromho per centimeter.

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

(iii) The activity of the water must then be determined.

(iv) The specimen must then be stored for at least seven days in still air at a temperature of 30°C (86°F) or greater.

(v) The process in paragraphs (c)(2)(i), (c)(2)(ii), and (c)(2)(iii) of this section must be repeated.

(vi) The activity determined in paragraph (c)(2)(iii) of this section may not exceed 2 kilobecquerels (0.05 microcurie).

(d) A specimen that comprises or simulates Class 7 (radioactive) material contained in a sealed capsule need not be subjected to—

(1) The impact test and the percussion test of this section provided that the specimen is alternatively subjected to the Class 4 impact test prescribed in ISO 2919–1980(e), ''Sealed Radioactive Sources Classification''; and

(2) The heat test of this section, provided the specimen is alternatively subjected to the Class 6 temperature test specified in the International Organization for Standardization document ISO 2919–1980(e), ''Sealed Radioactive Sources Classification.''

§ 173.471 Requirements for U.S. Nuclear Regulatory Commission approved packages.

In addition to the applicable requirements of the U.S. Nuclear Regulatory Commission (USNRC) and other requirements of this subchapter, any offeror of a Type B, Type B(U), Type B(M), or fissile material package that has been approved by the USNRC in accordance with 10 CFR part 71 must also comply with the following requirements:

(a) The offeror shall be registered with the USNRC as a party to the packaging approval, and make the shipment in compliance with the terms of the packaging approval;

(b) The outside of each package must be durably and legibly marked with the package identification marking indicated in the USNRC packaging approval;

(c) Each shipping paper related to the shipment of the package must bear the package identification marking indicated in the USNRC packaging approval;

(d) Before export shipment of the package, the offeror shall obtain a U.S. Competent Authority Certificate for that package design or if one has already been issued, the offeror shall register, in writing (including a description of the quality assurance program required by 10 CFR part 71) with the U.S. Competent Authority as a user of the certificate. (Note: The person who originally applies for a U.S. Competent Authority Certificate will be registered automatically.) Upon registration, the offeror will be furnished with a copy of the certificate. The offeror shall then submit a copy of the U.S. Competent Authority Certificate applying to that package design to the national competent authority of each country into or through which the package will be transported, unless the offeror has documentary evidence that a copy has already been furnished; and

(e) Each request for a U.S. Competent Authority Certificate as required by the IAEA regulations must be submitted in writing to the Associate Administrator for Hazardous Materials Safety. The request must be in triplicate and include copies of the applicable USNRC packaging approval, USNRC Quality Assurance Program approval number, and a reproducible 22 cm x 30 cm (8.5'' x 11'') drawing showing the make-up of the package. Each request is considered in the order in which it is received. To allow sufficient time for consideration, requests must be received at least 90 days before the requested effective date.

§ 173.472 Requirements for exporting DOT Specification Type B and fissile packages.

(a) Any offeror who exports a DOT Specification Type B or fissile material package authorized by § 173.416 or § 173.417 shall comply with paragraphs (b) through (f) of this section.

(b) The shipment must be made in accordance with the conditions of the U.S. Certificate of Competent Authority.

(c) The outside of each package must be durably and legibly marked with the package identification marking indicated in the U.S. Competent Authority Certificate.

(d) Each shipping paper related to the shipment of the package must bear the package identification marking indicated in the U.S. Competent Authority Certificate.

(e) Before export of the package, the offeror shall obtain a U.S. Competent Authority Certificate for that package design, or if one has already been issued, the offeror shall register in writing (including a description of the quality assurance program required by 10 CFR Part 71, subpart H, or 49 CFR 173.474 and 173.475) with the U.S. Competent Authority as a user of the certificate. Upon registration, the offeror will be furnished with a copy of the certificate. The offeror shall then submit a copy of the U.S. Competent Authority Certificate applying to that package design to the national competent authority of each country into or through which the package will be transported, unless the offeror has documentary evidence that a copy has already been furnished.

(f) Each request for a U.S. Competent Authority Certificate as required by IAEA regulations must be submitted in writing to the Associate Administrator for Hazardous Materials Safety. The request must be submitted in triplicate and must include a description of the quality assurance program required by 10 CFR Part 71, subpart H, or 49 CFR 173.474 and 173.475, and a reproducible 22 cm x 30 cm (8.5'' x 11'') drawing showing the make-up of the package. A copy of the USNRC quality assurance program approval will satisfy the requirement for describing the quality assurance program. Each request is considered in the order in which it is received. To allow sufficient time for consideration, requests must be received at least 90 days before the requested effective date.

§ 173.473 Requirements for foreign-made packages.

In addition to other applicable requirements of this subchapter, each offeror of a foreign-made Type B, Type B(U), Type B(M), or fissile material package for which a Competent Authority Certificate is required by IAEA's ''Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6,'' shall also comply with the following requirements:

(a) Prior to the shipment of such a package of Class 7 (radioactive) materials into or from the U.S., the offeror shall—

(1) Have the foreign competent authority certificate revalidated by the U.S. Competent Authority, unless this has been done previously. Each request for revalidation must be submitted in writing to the Associate Administrator for Hazardous Materials Safety. The request must be in triplicate, contain all the information required by Section VII of the IAEA regulations in Safety Series No. 6, and include a copy in English of the foreign competent authority certificate. Each request is considered in the order in which it is received. To allow sufficient time for consideration, requests must be received at least 90 days before the requested effective date;

(2) Register in writing with the U.S. Competent Authority as a user of the package covered by the foreign competent authority certificate and its U.S. revalidation. If the offeror is requesting the revalidation, registration is automatic; and

(3) Supply to the carrier, upon request, the applicable competent authority certificates. However, the competent authority certificates are not required to accompany the packages to which they apply.

(b) The outside of each package must be durably and legibly marked with the competent authority identification marking indicated on the Competent Authority Certificate and revalidation.

(c) Each shipping paper for a shipment of Class 7 (radioactive) materials must bear a notation of the package identification marking indicated on the competent authority certificate or revalidation.

(d) All requirements of the foreign competent authority certificate and the U.S. Competent Authority revalidation must be fulfilled.

§ 173.474 Quality control for construction of packaging.

Prior to the first use of any packaging for the shipment of Class 7 (radioactive) material, the offeror shall determine that—

(a) The packaging meets the quality of design and construction requirements as specified in this subchapter; and

(b) The effectiveness of the shielding, containment and, when required, the heat transfer characteristics of the package, are within the limits specified for the package design.

§ 173.475 Quality control requirements prior to each shipment of Class 7 (radioactive) materials.

Before each shipment of any Class 7 (radioactive) materials package, the offeror must ensure, by examination or appropriate tests, that—

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

(b) The packaging is in unimpaired physical condition, except for superficial marks;

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

(d) For fissile material, each moderator and neutron absorber, if required, is present and in proper condition;

(e) Each special instruction for filling, closing, and preparation of the packaging for shipment has been followed;

(f) Each closure, valve, or other opening of the containment system through which the radioactive content might escape is properly closed and sealed;

(g) Each packaging containing liquid in excess of an A_2 quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than 25 kPa, absolute (3.6 psia). The test must be conducted on the entire containment system, or on any receptacle or vessel within the containment system, to determine compliance with this requirement;

(h) The internal pressure of the containment system will not exceed the design pressure during transportation; and

(i) External radiation and contamination levels are within the allowable limits specified in this subchapter.

§ 173.476 Approval of special form Class 7 (radioactive) materials.

(a) Each offeror of special form Class 7 (radioactive) materials must maintain on file for at least one year after the latest shipment, and provide to the Associate Administrator for Hazardous Materials Safety on request, a complete safety analysis, including documentation of any tests, demonstrating that the special form material meets the requirements of § 173.469. An IAEA Certificate of Competent Authority issued for the special form material may be used to satisfy this requirement.

(b) Prior to the first export shipment of a special form Class 7 (radioactive) material from the United States, each offeror shall obtain a U.S. Competent Authority Certificate for the specific material. For special form material manufactured outside the United States, an IAEA Certificate of Competent Authority from the country of origin may be used to meet this requirement.

(c) Each request for a U.S. Competent Authority Certificate as required by the IAEA regulations must be submitted in writing, in triplicate, to the Associate Administrator for Hazardous Materials Safety. Each request is considered in the order in which it is received. To allow sufficient time for consideration, requests must be received at least 90 days before the requested effective date. Each petition for a U.S. Competent Authority Certificate must include the following information:

(1) A detailed description of the material, or if a capsule, a detailed description of the contents. Particular reference must be made to both physical and chemical states;

(2) A detailed statement of the capsule design and dimensions, including complete engineering drawings [22cm × 30cm (8½ inches × 11 inches)] and schedules of material, and methods of construction;

(3) A statement of the tests that have been made and their results; or evidence based on calculative methods to show that the material is able to pass the tests; or other evidence that the special form Class 7 (radioactive) material complies with § 173.469; and

(4) For the original request for a Competent Authority Certificate, evidence of a quality assurance program.

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

§ 173.477 Approval for export shipments.

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

(1) A vented Type B(M) package;

(2) A Type B(M) packaging containing Class 7 (radioactive) materials with an activity greater than 3×10^3 A_1, or 3×10^3 A_2, as appropriate, or 1000 TBq (27,000 curies), whichever is less;

(3) A shipment of packages containing fissile materials if the sum of the transport indices of the individual packages exceeds 50; or

(4) Transportation by special arrangement.

(b) Each application for shipment approval not under special arrangement must contain:

(1) The period of time for which the approval is sought;

(2) A description of the contents, the expected modes of transportation, the type of conveyance to be used, and the proposed route; and

(3) An explanation of how the special precautions and special administrative and operational controls referred to in the package design certificates are to be put into effect.

(c) Each application for shipment approval under special arrangement must contain:

(1) A statement of the reasons why the shipment cannot be made in accordance with the applicable requirements; and

(2) A statement of any special precautions or special administrative or operational controls that will be used during transport to ensure that the overall safety is at least equivalent to that provided by the applicable requirements.

(d) The packaging and shipment approvals may be combined into a single approval issued in accordance with §§ 173.471, 173.472 or 173.473.

(e) Approval by competent authorities is not required for packagings designed for materials covered by §§ 173.421 through 173.428 or for Type A packagings designed for non-fissile Class 7 (radioactive) materials.

§ 173.478 Notification to competent authorities for export shipments.

(a) Before the first export shipment of any packaging containing fissile materials packages exceeding 15 grams, or Class 7 (radioactive) materials exceeding A_1 or A_2, the offeror shall ensure that copies of each applicable competent authority certificate issued in accordance with § 173.471, § 173.472, or § 173.473 have been submitted to the competent authority of each country through which or into which it is to be transported. Except as specified in § 173.477, the offeror is not required to await an acknowledgment from the competent authority prior to shipping the Class 7 (radioactive) material, nor is the competent authority required to acknowledge receipt of the certificate.

(b) For each of the shipments described in this paragraph, the offeror shall notify the competent authority of each country through which or into which the shipment is to be transported. This notification must be received by each competent authority at least 7 days before the shipment starts for the following:

(1) Type B(U) packagings containing Class 7 (radioactive) materials with an activity greater than 3×10^3 A_1, 3×10^3 A_2, as appropriate, or 1000 TBq (27,000 Curies), whichever is the least;

(2) Type B(M) packages; or

(3) Transportation by special arrangements.

(c) The offeror notification must include:

(1) Sufficient information to enable the packaging to be identified, including all applicable certificate numbers and identification marks;

(2) Information as to the date of shipment, the expected date of arrival, and the proposed routing;

(3) The name of the Class 7 (radioactive) material or nuclide;

(4) A description of the physical and chemical form of the Class 7 (radioactive) material; and

(5) The maximum activity of the Class 7 (radioactive) material, except that for fissile material, the mass of fissile material may be used instead of activity.

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

PART 174—CARRIAGE BY RAIL

24. The authority citation for Part 174 continues to read as follows:

Authority: 49 U.S.C. 5101–5127; 49 CFR 1.53.

25. Sections 174.700 and 174.715 are revised and § 174.705 is added to read as follows:

§ 174.700 Special handling requirements for Class 7 (radioactive) materials.

(a) Each rail shipment of low specific activity materials or surface contaminated objects as defined in § 173.403 of this subchapter must be loaded so as to avoid spillage and scattering of loose material. Loading restrictions are prescribed in § 173.427 of this subchapter.

(b) The number of packages of Class 7 (radioactive) materials that may be transported by rail or stored at any single location is limited to a total transport index number (as defined in § 173.403 of this subchapter) of not more than 50. This provision does not apply to exclusive use shipments as described in §§ 173.403, 173.427, 173.441, and 173.457 of this subchapter.

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

Total transport index	Minimum separation distance to nearest undeveloped film		Minimum distance to area of persons or minimum distance from dividing partition of a combination car	
	Meters	Feet	Meters	Feet
None	0	0	0	0
0.1 to 10.0	4.5	15	0.9	3
10.1 to 20.0	6.7	22	1.2	4
20.1 to 30.0	7.7	29	1.5	5
30.1 to 40.0	10	33	1.8	6
40.1 to 50.0	10.9	36	2.1	7

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

(d) Each fissile material, controlled shipment must be transported in accordance with one of the methods prescribed in § 173.457 of this subchapter. The transport controls must be adequate to assure that no fissile material, controlled shipment is transported in the same transport vehicle with any other fissile Class 7 (radioactive) material shipment. In loading and storage areas, each fissile material, controlled shipment must be segregated by a distance of at least 6 meters (20 feet) from other packages required to bear one of the ''radioactive'' labels described in Part 172 of this subchapter.

(e) A person shall not remain unnecessarily in, on or near a transport vehicle containing Class 7 (radioactive) materials.

(f) In the case of packages shipped under the exclusive use provisions of § 173.441(b) of this subchapter for packages with external radiation levels in excess of 2 mSv per hour (200 mrem per hour) at the package surface—

(1) The transport vehicle must meet the requirements for a closed transport vehicle (§ 173.403 of this subchapter);

(2) Each package must be secured so that its position within the transport vehicle remains fixed under conditions normally incident to transportation; and

(3) The radiation level may not exceed 0.02 mSv per hour (2 mrem per hour) in any normally occupied position in the transport vehicle or adjacent rail car.

§ 174.705 Radiation protection program.

Unless otherwise excepted, a carrier shall not transport a Class 7 (radioactive) material by rail unless each of its occupationally exposed hazmat employees is under a radiation protection program that complies with the requirements of subpart I of part 172 of this subchapter.

§ 174.715 Cleanliness of transport vehicles after use.

(a) Each transport vehicle used for transporting Class 7 (radioactive) materials as exclusive use, as defined in § 173.403 of this subchapter, must be surveyed with appropriate radiation detection instruments after each use. A transport vehicle may not be returned to service until the radiation dose rate at any accessible surface is 0.005 mSv per hour (0.5 mrem per hour) or less, and there is no significant removable radioactive surface contamination, as defined in § 173.443 of this subchapter.

(b) This section does not apply to any transport vehicle used solely for transporting Class 7 (radioactive) materials if a survey of the interior surface shows that the radiation does rate does not exceed 0.1 mSv per hour (10 mrem per hour) at the interior surface or 0.02 mSv per hour (2 mrem per hour) at 1 meter (3.3 feet) from any interior surface. The transport vehicle must be stenciled with the words ''FOR RADIOACTIVE MATERIALS USE ONLY'' in lettering at least 7.6 centimeters (3 inches) high in a conspicuous place on both sides of the exterior of the transport vehicle, and it must be kept closed at all times other than during loading and unloading.

26. In § 174.750, paragraph (a) is revised to read as follows:

§ 174.750 Incidents involving leakage.

(a) In addition to the incident reporting requirements of §§ 171.15 and 171.16 of this subchapter, the carrier shall also notify the offeror at the earliest practicable moment following any incident in which there has been breakage, spillage, or suspected radioactive contamination involving Class 7 (radioactive) materials shipments. Transport vehicles, buildings, areas, or equipment in which Class 7 (radioactive) materials have been spilled may not be again placed in service or routinely occupied until the radiation dose rate at every accessible surface is less than 0.005 mSv per hour (0.5 mrem per hour) and there is no significant removable radioactive surface contamination (see § 173.443 of this subchapter).

* * * * *

PART 175—CARRIAGE BY AIRCRAFT

27. The authority citation for Part 175 continues to read as follows:

Authority: 49 U.S.C. 5101–5127; 49 CFR 1.53.

28. In § 175.700, paragraphs (b) and (c) are revised to read as follows:

§ 175.700 Special limitations and requirements for Class 7 (radioactive) materials.

* * * * *

(b) In addition to the reporting requirements of § 175.45, the carrier shall also notify the offeror at the earliest practicable moment following any incident in which there has been breakage, spillage, or suspected radioactive contamination involving Class 7 (radioactive) materials shipments. Aircraft in which Class 7 (radioactive) materials have been spilled may not again be placed in service or routinely occupied until the radiation dose rate at every accessible surface is less than 0.005 mSv per hour (0.5 mrem per hour) and there is no significant removable radioactive surface contamination as determined in accordance with § 173.443 of this subchapter. When contamination is present or suspected, the package and/or materials it has touched must be segregated as far as practicable from personnel contact until appropriate radiological advice or assistance is obtained. The Regional Office of the U.S. Department of Energy or appropriate State or local radiological authorities can provide advice or assistance, and should be notified in cases of obvious leakage, or if it appears likely that the inside container may have been damaged. For personnel safety, the carrier shall take care to avoid possible inhalation, ingestion, or contact by any person with Class 7 (radioactive) materials that may have leaked or spilled from its package. Any loose Class 7 (radioactive) materials and associated packaging materials must be left in a segregated area pending disposal instructions from responsible radiological authorities.

(c) Except as provided in §§ 173.4, 173.422 and 173.423 of this subchapter, no person shall carry any Class 7 (radioactive) materials aboard a passenger carrying aircraft unless that material is intended for use in, or incident to research, medical diagnosis or treatment.

* * * * *

29. In § 175.703, the introductory text of paragraph (c) and paragraph (d) are revised to read as follows:

§ 175.703 Other special requirements for the acceptance and carriage of packages containing Class 7 (radioactive) materials.

* * * * *

(c) No person shall carry in an aircraft a fissile material controlled shipment (as defined in § 173.403 of this subchapter), except—

* * * * *

(d) No person shall offer or accept for transportation, or transport, byair—

(1) Vented Type B(M) packages, packages which require external cooling by an ancillary cooling system or packages subject to operational controls during transport; or

(2) Liquid pyrophoric Class 7 (radioactive) materials.

* * * * *

30. Sections 175.704 and 175.706 are added to read as follows:

§ 175.704 Plutonium shipments.

Shipments of plutonium by air which are subject to 10 CFR 71.88(a)(4) must comply with the following:

(a) A plutonium package weighing less than 40 kg (88 lbs) and having its height and diameter both less than 50 cm (19.7 in), must be stowed aboard the aircraft on the main deck or the lower cargo compartment in the aft-most location that is possible for cargo of its size and weight. No other type of cargo may be stowed aft of a plutonium package.

(b) A plutonium package must be secured and restrained to prevent shifting under normal transport. A plutonium package weighing 40 kg (88 lbs) or more must be securely cradled and tied down to the main deck of the aircraft such that the tied down system is capable of providing package restraint against the following inertial forces acting separately relative to the deck of the aircraft: Upward, 2g; Forward, 9g; Sideward, 1.5g; Downward, 4.5g.

(c) A plutonium package weighing less than 40 kg (88 lbs), and having its height and diameter both less than 50 cm (19.7 in), may not be transported aboard an aircraft carrying other cargo required to bear an ''Explosive A'' or an ''Explosive 1.1'' label. Any other plutonium package may not be transported aboard an aircraft carrying other cargo bearing any of the following hazardous material labels: Explosive A; Explosive B; Explosive C; Explosive 1.1, 1.2, 1.3, 1.4, 1.5 or 1.6; Spontaneously Combustible; Dangerous When Wet; Organic Peroxide; Non-Flammable Gas; Flammable Liquid; Flammable Solid; Flammable Gas; Oxidizer; or Corrosive.

§ 175.706 Radiation protection program.

Unless otherwise excepted, a carrier shall not transport a Class 7 (radioactive) material by aircraft unless each of its occupationally exposed hazmat employees is under a radiation protection program that complies with the requirements of subpart I of part 172 of this subchapter.

PART 176—CARRIAGE BY VESSEL

31. The authority citation for Part 176 continues to read as follows:

Authority: 49 U.S.C. 5101–5127; 49 CFR 1.53.

32. In § 176.700, paragraph (a) is removed and reserved and paragraph (c) is revised to read as follows:

§ 176.700 General stowage requirements.

(a) [Reserved]

* * * * *

(c) Each fissile material, controlled shipment must be stowed in a separate hold, compartment, or defined deck area and be separated by a distance of at least six meters (20 feet) from all other RADIOACTIVE YELLOW–II or YELLOW–III labeled packages.

* * * * *

33. Section 176.703 is added to read as follows:

§ 176.703 Radiation protection program.

Unless otherwise excepted, a carrier shall not transport a Class 7 (radioactive) material by vessel unless each of its occupationally exposed hazmat employees is under a radiation protection program that complies with the requirements of subpart I of part 172 of this subchapter.

33a. Section 176.704 is revised to read as follows:

§ 176.704 Requirements relating to transport indexes.

(a) The sum of the transport indexes for all packages of Class 7 (radioactive) materials on board a vessel may not exceed the limits specified in Table III.

(b) For packages in freight containers, the radiation level may not exceed 2 mSv per hour (200 mrem per hour) at any point on the surface and 0.1 mSv per hour (10 mrem per hour) at two meters (6.6 feet) from the outside surface of the freight container.

(c) The limitations specified in Table III do not apply to consignments of LSA–I materials if the packages are marked ''RADIOACTIVE LSA–I'' and no fissile Class 7 (radioactive) materials are included in the shipment.

(d) Each group of fissile packages must be separated from other Class 7 (radioactive) material by a distance of at least six meters (20 feet) at all times.

(e) The limitations specified in paragraphs (a) through (c) of this section do not apply when the entire vessel is reserved or chartered for use by a single offeror under exclusive use conditions if—

(1) The number of fissile packages of Class 7 (radioactive) materials aboard the vessel does not exceed the amount

authorized in § 173.451 through § 173.459 of this subchapter; and

(2) The entire shipment operation is approved by the Associate Administrator for Hazardous Materials Safety in advance.

(f) Table III is as follows:

TABLE III.—TI LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES

Type of freight container or conveyance	Limit on total sum of transport indexes in a single freight container or aboard a conveyance			
	Not under exclusive use		Under exclusive use	
	Non-fissile material	Fissile material	Non-fissile material	Fissile material[a]
Freight container—Small	50	50	N/A	N/A.
Freight container—Large	50	50	No limit	100[b].
Vessel[c]:				
1. Hold, compartment or defined deck area:				
Packages, overpacks, small freight containers	50	50	No limit	100[b].
Large freight containers	200[d]	50	No limit	100[b].
2. Total vessel:				
Packages, etc.	200[d]	200[d]	No limit[e].	200[e].
Large freight containers	No limit[d]	No limit[d]	No limit	No limit[d].

[a] Provided that transport is direct from the consignor to the consignee without any intermediate in-transit storage, where the total TI exceed 50.
[b] In cases in which the total TI is greater than 50, the consignment must be so handled and stowed so that it is always separated from any package, overpack, portable tank or freight container carrying Class 7 (radioactive) materials by at least 6 meters (20 feet).
[c] For vessels the requirements given in 1 and 2 must be fulfilled.
[d] Provided that the packages, overpacks, portable tanks or freight containers, as applicable, are stowed so that the total sum of the TI's in any group does not exceed 50, and that each group is handled and stowed so that the groups are separate from each other by at least 6 meters (20 feet).
[e] Packages or overpacks carried in or on a transport vehicle which are offered for transport under the provisions of § 173.441(b) of this subchapter may be transported by vessel provided that they are not removed from the vehicle at anytime while on board the vessel.

34. In § 176.708, TABLE III is redesignated as TABLE IV, paragraph (a) is revised and paragraphs (b) through (f) are added to read as follows:

§ 176.708 Segregation distance table.

(a) Table IV applies to the stowage of packages of Class 7 (radioactive) materials on board a vessel with regard to transport index numbers which are shown on the labels of individual packages.

(b) RADIOACTIVE YELLOW–II or YELLOW–III labeled packages may not be stowed any closer to living accommodations, regularly occupied working spaces, spaces that may be continually occupied by any person (except those spaces exclusively reserved for couriers specifically authorized to accompany such packages), or undeveloped film than the distances specified in TABLE IV.

(c) Where only one consignment of a Class 7 (radioactive) material is to be loaded on board a vessel under exclusive use conditions, the appropriate segregation distance may be established by demonstrating that the direct measurement of the radiation level at regularly occupied working spaces and living quarters is less than 7.5 microsieverts per hour (0.75 mrem per hour).

(d) More than one consignment may be loaded on board a vessel with the appropriate segregation distance established by demonstrating that direct measurement of the radiation level at regularly occupied working spaces and living quarters is less than 7.5 microSieverts per hour (0.75 mrem per hour), provided that:

(1) The vessel has been chartered for the exclusive use of a competent person specialized in the carriage of Class 7 (radioactive) material; and

(2) Stowage arrangements have been predetermined for the entire voyage, including any Class 7 (radioactive) material to be loaded at ports of call enroute.

(e) The radiation level must be measured by a responsible person skilled in the use of monitoring instruments.

(f) Table IV is as follows:

* * * * *

35. Section 176.715 is revised to read as follows:

§ 176.715 Contamination control.

Each hold, compartment, or deck area used for the transportation of low specific activity or surface contaminated object Class 7 (radioactive) materials under exclusive use conditions must be surveyed with appropriate radiation detection instruments after each use. Such holds, compartments, and deck areas may not be used again until the radiation dose rate at every accessible surface is less than 5 microSieverts per hour (0.5 mrem per hour), and the removable (non-fixed) radioactive surface contamination is not greater than the limits prescribed in § 173.443 of this subchapter.

PART 177—CARRIAGE BY PUBLIC HIGHWAY

36. The authority citation for Part 177 continues to read as follows:

Authority: 49 U.S.C. 5101–5127; 49 CFR 1.53.

37. Section 177.827 is added to subpart A to read as follows:

§ 177.827 Radiation protection program.

Unless otherwise excepted, a carrier shall not transport a Class 7 (radioactive) material by motor vehicle unless each of its occupationally exposed hazmat employees is under a radiation protection program that complies with the requirements of subpart I of part 172 of this subchapter.

38. Section 177.842 is revised to read as follows:

§ 177.842 Class 7 (radioactive) material.

(a) The number of packages of Class 7 (radioactive) materials in any transport vehicle or storage location must be limited so that the total transport index number does not exceed 50. The total transport index of a group of packages and overpacks is determined by adding together the transport index number on the labels on the individual packages and overpacks in the group. This provision does not apply to exclusive use shipments

described in §§ 173.441(b), 173.457, and 173.427 of this subchapter.

(b) Packages of Class 7 (radioactive) material bearing ''RADIOACTIVE YELLOW–II'' or ''RADIOACTIVE YELLOW–III'' labels may not be placed in a transport vehicle, storage location or in any other place closer than the distances shown in the following table to any area which may be continuously occupied by any passenger, employee, or animal, nor closer than the distances shown in the table to any package containing undeveloped film (if so marked), and must conform to the following conditions:

(1) If more than one of these packages is present, the distance must be computed from the following table on the basis of the total transport index number determined by adding together the transport index number on the labels on the individual packages and overpacks in the vehicle or storeroom.

(2) Where more than one group of packages is present in any single storage location, a single group may not have a total transport index greater than 50. Each group of packages must be handled and stowed not closer than 6 meters (20 feet) (measured edge to edge) to any other group. The following table is to be used in accordance with the provisions of paragraph (b) of this section:

Total transport index	Minimum separation distance in meters (feet) to nearest undeveloped film in various times of transit					Minimum distance in meters (feet) to area of persons, or minimum distance in meters (feet) from dividing partition of cargo compartments
	Up to 2 hours	2–4 hours	4–8 hours	8–12 hours	Over 12 hours	
None	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
0.1 to 1.0	0.3 (1)	0.6 (2)	0.9 (3)	1.2 (4)	1.5 (5)	0.3 (1)
1.1 to 5.0	0.9 (3)	1.2 (4)	1.8 (6)	2.4 (8)	3.4 (11)	0.6 (2)
5.1 to 10.0	1.2 (4)	1.8 (6)	2.7 (9)	3.4 (11)	4.6 (15)	0.9 (3)
10.1 to 20.0	1.5 (5)	2.4 (8)	3.7 (12)	4.9 (16)	6.7 (22)	1.2 (4)
20.1 to 30.0	2.1 (7)	3.0 (10)	4.6 (15)	6.1 (20)	8.8 (29)	1.5 (5)
30.1 to 40.0	2.4 (8)	3.4 (11)	5.2 (17)	6.7 (22)	10.1 (33)	1.8 (6)
40.1 to 50.0	2.7 (9)	3.7 (12)	5.8 (19)	7.3 (24)	11.0 (36)	2.1 (7)

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

(c) Shipments of low specific activity materials and surface contaminated objects, as defined in § 173.403 of this subchapter, must be loaded so as to avoid spillage and scattering of loose materials. Loading restrictions are set forth in § 173.427 of this subchapter.

(d) Packages must be so blocked and braced that they cannot change position during conditions normally incident to transportation.

(e) Persons should not remain unnecessarily in a vehicle containing Class 7 (radioactive) materials.

(f) Each fissile material, controlled shipment (as defined in § 173.403 of this subchapter) must be transported in accordance with one of the methods prescribed in § 173.457 of this subchapter. The transport controls must be adequate to assure that no fissile material, controlled shipment is transported in the same transport vehicle with any other fissile Class 7 (radioactive) material shipment. In loading and storage areas each fissile material, controlled shipment must be segregated by a distance of at least 6 meters (20 feet) from any other package required to bear one of the ''Radioactive'' labels described in § 172.403 of this subchapter.

(g) For shipments transported under exclusive use conditions the radiation dose rate may not exceed 0.02 mSv per hour (2 mrem per hour) in any position normally occupied in the motor vehicle. For shipments transported as exclusive use under the provisions of § 173.441(b) of this subchapter for packages with external radiation levels in excess of 2 mSv (200 mrem per hour) at the package surface, the motor vehicle must meet the requirements of a closed transport vehicle (§ 173.403 of this subchapter). The total transport index for packages containing fissile material may not exceed 100.

39. In § 177.843, paragraphs (a) and (b) are revised to read as follows:

§ 177.843 Contamination of vehicles.

(a) Each motor vehicle used for transporting Class 7 (radioactive) materials under exclusive use conditions in accordance with § 173.427(b)(3) or (c) or § 173.443(c) of this subchapter must be surveyed with radiation detection instruments after each use. A vehicle may not be returned to service until the radiation dose rate at every accessible surface is 0.005 mSv per hour (0.5 mrem per hour) or less and the removable (non-fixed) radioactive surface contamination is not greater than the level prescribed in § 173.443(a) of this subchapter.

(b) This section does not apply to any vehicle used solely for transporting Class 7 (radioactive) material if a survey of the interior surface shows that the radiation dose rate does not exceed 0.1 mSv per hour (10 mrem per hour) at the interior surface or 0.02 mSv per hour (2 mrem per hour) at 1 meter (3.3 feet) from any interior surface. These vehicles must be stenciled with the words ''For Radioactive Materials Use Only'' in lettering at least 7.6 centimeters (3 inches) high in a conspicuous place, on both sides of the exterior of the vehicle. These vehicles must be kept closed at all times other than loading and unloading.

* * * * *

40. In § 177.861, paragraph (a) is revised and Notes 1 and 2 are removed as follows:

§ 177.861 Accidents; Class 7 (radioactive) materials.

(a) In addition to the incident reporting requirements of §§ 171.15 and 171.16 of this subchapter, the carrier shall also notify the offeror at the earliest practicable moment following any incident in which there has been breakage, spillage, or suspected

radioactive contamination involving Class 7 (radioactive) materials shipments. Vehicles, buildings, areas, or equipment in which Class 7 (radioactive) materials have been spilled may not be again placed in service or routinely occupied until the radiation dose rate at every accessible surface is less than 0.005 mSv per hour (0.5 mrem per hour) and there is no significant removable radioactive surface contamination (see § 173.443 of this subchapter).

* * * * *

PART 178—SPECIFICATIONS FOR PACKAGINGS

41. The authority citation for Part 178 continues to read as follows:

Authority: 49 U.S.C. 5101–5127; 49 CFR 1.53.

42. Section 178.350 is revised to read as follows:

§ 178.350–1 Specification 7A; general packaging, Type A.

(a) Each packaging must meet all applicable requirements of subpart B of Part 173 of this subchapter and be designed and constructed so that it meets the requirements of §§ 173.403, 173.410, 173.412, 173.415 and 173.465 of this subchapter for Type A packaging.

(b) Each Specification 7A packaging must be marked on the outside ''USA DOT 7A Type A'' and ''Radioactive Material.''

§§ 178.350–1 through 178.350–3 [Removed]

43. Sections 178.350–1, 178.350–2, and 178.350–3 are removed.

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Ana Sol Gutiérrez,

Deputy Administrator, Research and Special Programs Administration.

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