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Regulatory Analysis of Major Revision of 10 CFR Part 71
Final Rule

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ABSTRACT

This report presents the regulatory analysis of the Nuclear Regulatory Commission's (NRC or Commission) rulemaking that would modify 10 CFR Part 71 requirements pertaining to the packaging and transport of radioactive materials, including fissile materials. The rulemaking is intended to: (1) harmonize 10 CFR Part 71 with the most recent transportation standards established by the International Atomic Energy Agency (IAEA), and the U.S. Department of Transportation's (DOT) requirements at 49 CFR; and (2) address the Commission's goals for risk-informed regulations and eliminating inconsistencies between Part 71 and other parts of 10 CFR. This report includes: (1) a summary of the findings, (2) a discussion of the regulatory options analyzed, (3) an assessment of the estimated values (benefits) and impacts (costs) identified for each regulatory option, (4) a rationale for the determination of the preferred option, and (5) supplementary information and analyses used in the development of this report. The analysis indicates that most of the changes will have negligible impacts or result in slight increases in values. The values and impacts of one change - incorporating a change process into Part 71 - are undetermined.

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EXECUTIVE SUMMARY

This document presents the Regulatory Analysis of the U.S. Nuclear Regulatory Commission's (NRC or Commission's) rulemaking that modifies Title 10 of the Code of Federal Regulations, Part 71 (10 CFR Part 71) requirements pertaining to the packaging and transport of radioactive materials, including fissile materials. The final rule will:

(1) Harmonize transportation regulations found in 10 CFR Part 71 with the most recent transportation standards established by the International Atomic Energy Agency (IAEA) (*Regulations for the Safe Transport of Radioactive Material*, IAEA Safety Standards Series No. TS-R-1, June 2000), and the U.S. Department of Transportation's requirements at 49 CFR; and

(2) Address the Commission's goals for risk-informed regulations and eliminate inconsistencies between Part 71 and other parts of 10 CFR.

The intended effects of the regulatory action are to develop a level of consistency with other regulatory agencies, and to implement other NRC-initiated changes needed to simplify the regulations applicable to licensees shipping radioactive materials, while maintaining adequate protection of public health, safety, and the environment. The final rule accomplishes these objectives by adopting a number of requirements that are consistent with the safe transportation standards contained in IAEA's TS-R-1, implementing other non-IAEA related changes, and implementing a number of recommendations contained in NUREG/CR-5342 (*Assessment and Recommendations for Fissile-Material Packaging Exemptions and General Licenses Within 10 CFR Part 71,* Oak Ridge National Laboratory, July 1998). The final rule addresses a total of 19 issues.

Table ES-1 provides a summary of the preferred option for each of the 19 individual issues described in Chapter 2 and analyzed in Chapter 3 of this document. In the paragraphs following this table, further description of the values and impacts of the options is provided. Chapters 2 and 3 provide additional detail on the changes and associated values and impacts.

Table ES-1. Summary of Preferred Options

Technical Issue		Preferred Option
1.	Changing Part 71 to the International System of Units (SI) Only	Option 1 (No Action)
2.	Radionuclide Exemption Values	Option 2
3.	Revision of A_1 and A_2	Option 2
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15.	Change Authority	Undetermined
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18.	Contamination Limits as Applied to Spent Fuel and High Level Waste (HLW) Packages	For information only. No options identified.
19.	Modifications of Event Reporting Requirements	Option 2

For purposes of this analysis, the final rule is grouped into the 19 different potential changes to Part 71 included in the *Federal Register*. None of the 19 changes, which are described and evaluated in turn in the remainder of this report, result in significant impacts (costs). In fact, most of the changes have negligible effects or result in slight increases in values (benefits). In particular, the following changes are primarily administrative in nature and result in the beneficial effect of simplifying and/or harmonizing the NRC's regulations with the latest international standards:

- Changing Part 71 to the International System of Units (SI) Only (see Sections 2.1.1 and 3.3.1);
- Revision of A_1 and A_2 (see Sections 2.1.3 and 3.3.3);
- A new requirement to display the Criticality Safety Index on shipping packages of fissile material (see Sections 2.1.5 and 3.3.5);
- A provision to "grandfather" older shipping packages under the Part 71 requirements in existence when their Certificates of Compliance (CoC) were issued (see Sections 2.1.8 and 3.3.8);
- Procedures for approval of special arrangements for shipment of special packages (see Sections 2.2.1 and 3.4.1);
- Modifications to Event Reporting Requirements (see Sections 2.2.8 and 3.4.8).

IAEA-Related Changes

The changes to harmonize Part 71 with TS-R-1 are expected to result in a net benefit in terms of regulatory efficiency, which will result in reduced costs. In addition, the change to various definitions would result in clarification of the requirements, thus slightly reducing burden for licensees. In whole, however, each change results in mixed, but overall minor, effects. Due to a lack of quantitative data it is not possible to describe the net value or impact of each change in terms of costs. The following paragraphs describe the preferred option for each issue, and further provide a qualitative summary of the values and impacts associated with the changes.

Changing Part 71 to the International System of Units (SI) Only. The preferred option is Option 1, the No-Action alternative. As described in Section 3.3.1, the change to the use of SI units only will result in minor values and impacts. While regulatory efficiency would be increased, the change could result in additional exposure of workers and the public to radiation due to possible flawed conversions from SI units to customary units. However, the frequency to which these individuals are exposed to radiation is not expected to increase because transportation accident frequency would not increase as a result of this change. Finally, additional costs would be incurred by licensees, the NRC, and other government agencies to implement the change.

Radionuclide Exemption Values. The preferred option is Option 2. Under this option, NRC is adopting the radionuclide exemption values contained in TS-R-1. Adoption of the TS-R-1 radionuclide exemption values is expected to have minor benefits as well as impacts (see

Section 3.3.2). Licensees may incur some minor administrative costs as well as costs to determine whether exemption levels are met. However, these costs are outweighed by the increase in regulatory efficiency between regulatory agencies and the facilitation of international shipments of exempted packages.

Revision of A_1 and A_2. The preferred option is Option 2. Option 2 recommends adoption of the newly revised A_1 and A_2 values in TS-R-1, with the exception of the values for ^{99}Mo and ^{252}Cf. Overall, it is expected that there will be a slight benefit in terms of potential exposure as a result of changing to the more refined values contained in TS-R-1 (see Section 3.3.3). Minor costs could be realized by licensees, the NRC, and other government agencies as a result of this change. In particular, licensees could incur implementation costs if licensees must revise various aspects of shipping programs or modify shipping processes to assure compliance with the proposed A_1 and A_2 values. These one-time costs, however, are expected to be minimal and are outweighed by the benefit of reduction in potential exposure.

Uranium Hexafluoride (UF_6) Package Requirements. Option 2 is the preferred option. NRC is promulgating a new § 71.55(g), consistent with the UF_6 exception requirements contained in TS-R-1, while restricting the use of this exception to packages with a maximum enrichment of five weight percent ^{235}U. Adoption of Option 2 (see Section 3.3.4) is expected to cause a slight increase in regulatory efficiency with respect to international shipments. No costs to industry or NRC are expected.

Introduction of the Criticality Safety Index Requirements. Option 2, the preferred option, requires labels indicating both the Transportation Index (TI) and the Criticality Safety Index (CSI) for transport of fissile material packages. The addition of the CSI in transport (see Section 3.3.5) is expected to result in minor implementation and operational costs for licensees, while providing a benefit to emergency responders in the case of transportation accidents. Additional benefits will be realized by the NRC for international shipments because regulatory efficiency would be increased.

Type C Packages and Low Dispersible Material. The preferred option is Option 1, the no-action alternative. Under this option, NRC will not adopt the Type C package or low dispersible radioactive material concepts for air transportation contained in TS-R-1. Incorporation of these concepts will result in an increase in regulatory efficiency as a result of the adoption of the TS-R-1 requirements, which will facilitate international shipments (see Section 3.3.6). Additional resource costs will, however, be incurred by NRC and the licensees. These additional costs to licensees will include implementation costs for the design of new packages to meet the Type C requirements rather using existing Type B packages. However, NRC currently has in place requirements governing domestic shipments of plutonium by air (which would be shipped in the new Type C packages) and because there are very few shipments of this nature, there is little need for this new type of package design in domestic commerce. As a result, the impacts outweigh the benefits of adopting these concepts.

Deep Immersion Test. Option 2 is the preferred option. Option 2 entails revising Part 71 to require an enhanced water immersion test for transporting packages containing radioactive materials with activity greater than 10^5 A_2. Requiring an enhanced deep immersion test (see Section 3.3.7) will improve regulatory efficiency by bringing U.S. regulations in harmony with the standards contained in TS-R-1. This will improve the efficiency of handling imports and exports and will make U.S. standards compatible with other IAEA member states. However, the requirement could result in costs to licensees as they test and certify packages to the proposed standard. The NRC also may incur costs for developing procedures, reviewing and approving test results, and recertifying packages. Alternatively, the proposed change may reduce impacts to public health in the case of an accident. Adoption of the change will prevent the possible expenses of restricting the accident area (to prevent users, such as boaters or fishers from entering the vicinity) and remediating any contamination of the marine environment. The net effect is that the values of adopting Option 2 outweigh the potential costs to licensees.

Grandfathering Previously Approved Packages. The preferred option is Option 2. Option 2 modifies Part 71 to phase out packages approved under IAEA Safety Series 6 (1967). This option includes a 4-year transition period for the grandfathering provision on packages approved under Safety Series 6. In addition, packages approved under Safety Series 6 (1985) would not be allowed to be fabricated after December 31, 2007. However, package designs approved under any pre-1996 IAEA standards (i.e., packages with a "-85" or earlier identification number) may be resubmitted to the NRC for review against current standards. If the package design described in the resubmitted application meets the current standards, the NRC may issue a new CoC for that package design with a "-96" designation. NRC understands that the purpose of grandfathering is to minimize the costs and impacts of implementing changes in the regulations on existing package designs and packagings. The revisions related to grandfathering of previously approved packages (see Section 3.3.8) will result in enhanced regulatory efficiency by bringing NRC's requirements in harmony with those contained in TS-R-1. The change will, however, result in implementation costs to the NRC because the Agency would have to revise regulatory guides and NUREG-series documents. The change could result in implementation and operation costs to Agreement States if they adopt and implement parallel requirements. While minimal costs may be realized by licensees, it is expected that the overall expected benefits outweigh the additional costs.

Changes to Various Definitions. Option 2 is the preferred option. Under Option 2, NRC is adding various definitions to 10 CFR 71.4 and modifying existing definitions to ensure compatibility with definitions found in TS-R-1, and to improve clarity in NRC regulations. These changes provide greater internal consistency with other NRC regulations and greater compatibility with TS-R-1, thus improving regulatory efficiency (see Section 3.3.9). By modifying existing definitions and adding new definitions, licensees also will benefit through more effective understanding of the requirements of Part 71. The changes result in implementation costs to the NRC, with respect to revisions necessary to regulatory guides and NUREG-series documents. The changes could affect Agreement States in a similar fashion. However, the increased regulatory efficiency and greater clarification for licensees outweigh the costs to NRC.

Crush Test for Fissile Material Package Design. The preferred option is Option 2. Option 2 recommends adoption, in part, of the TS-R-1 requirement for a crush test for radioactive contents of Type B packages greater than 1000 A_2. In addition, Option 2 extends the crush test requirement to fissile material package designs regardless of the level of radioactive contents. Adoption of Option 2 (see Section 3.3.10) results in enhanced regulatory efficiency by correcting inconsistencies between Part 71 requirements and TS-R-1. However, further information on the impact of the TS-R-1 requirement for fissile material package testing is required. The change also results in implementation costs imposed on licensees to demonstrate compliance and may lead to the redesign of packages. Lastly, the change will result in NRC implementation costs associated with modifying the regulations and revising guidance documents.

Fissile Material Package Designs for Transport by Aircraft. Option 2, the preferred option, results in the adoption of the TS-R-1 criticality evaluation requirements for shipment of fissile packages by aircraft. Option 2 provides the NRC with the regulatory framework for approving package designs that will be used internationally (see Section 3.3.11). NRC costs will be reduced while maintaining consistency with international requirements, thus enhancing regulatory efficiency. Shippers are required to meet these requirements because the International Civil Aviation Organization (ICAO) is adopting regulations consistent with TS-R-1 effective July 1, 2001; thus, no additional costs are imposed on licensees by NRC's final rule. Further, some U.S. domestic air carriers already require compliance with the ICAO regulations even for domestic shipments.

NRC-Initiated Changes

Special Package Authorizations. Option 2 is the preferred option. Under this option, NRC will incorporate new regulations in Part 71 that address approval for shipment of special packages and that demonstrate an acceptable level of safety. Incorporation of the new regulations (see Section 3.4.1) will result in enhanced regulatory efficiency by standardizing the requirements for special package approval to provide greater regulatory certainty and clarity. It also ensures consistent treatment among licensees requesting authorization for shipment of special packages. Since the change is expected to streamline the process for handling nonstandard packages, considerable savings will be realized, both in NRC staff time and licensee staff time. Further, the regulations require a demonstration of an acceptable level of safety for shipment of these packages, and the result is expected to be a decreased risk of radiation exposure to the public and workers as opposed to the shipment alternatives.

Expansion of Part 71 Quality Assurance Requirements to Certificate of Compliance (CoC) Holders. The preferred option is Option 2. Option 2 recommends that NRC explicitly subject CoC holders and CoC applicants to the requirements contained in 10 CFR Part 71. NRC also will add recordkeeping and reporting requirements for CoC holders and CoC applicants. Adoption of the change for bringing CoC holders and applicants under authority of Part 71 (see Section 3.4.2) ensures that Part 71 is more consistent with other NRC regulations (thus enhancing regulatory efficiency) in that certificate holders and applicants for a CoC are responsible for the behavior of their contractors and subcontractors. CoC holders and applicants for a CoC will incur costs associated with understanding and implementing the new regulations, as well as in preparing and submitting reports. NRC will incur costs associated with supervising certificate holders and applicants for a CoC and maintaining and reviewing the records for certificate holder submittals. Overall, the increased efficiency and improved consistency with other NRC regulations outweigh the costs to CoC holders and applicants.

Adoption of ASME Code. Option 1, the No-Action alternative, is the preferred option. The adoption of the changes to incorporate the ASME Code (see Section 3.4.3) will result in additional implementation and operational costs to licensees. Adoption of this code is expected to result in some benefit with respect to public health. However, because of the potential for the ASME code to be revised over the next several years, adoption at this time could result in additional costs to both NRC and licensees should the regulations need to be revised in the future.

Change Authority. The values and impacts of the proposed change authority in Part 71 is currently undetermined.

Fissile Material Exemptions and General License Provisions. Option 2 is the preferred option. Under Option 2, NRC is adopting 16 of the 17 recommendations contained in NUREG/CR-5342. (Recommendation 6 will not be adopted.)

Double Containment of Plutonium. Option 2 is the preferred option. Under Option 2, NRC is adopting, in part, the recommended action of Petition PRM-71-12. Specifically, NRC will remove the double containment requirement of § 71.63(b). However, the NRC will retain the package contents requirement in § 71.63(a) — shipments whose contents contain greater than 0.74 TBq (20 Ci) of plutonium must be made with the contents in solid form. Adoption of the change for the double containment of plutonium (see Section 3.4.6) will result in implementation and operational savings for licensees and other government agencies (e.g., DOE). However, because the NRC believes that the current Type B package requirements are sufficient to protect human health and safety, the change is not expected to result in increased costs as a result of exposure to radiation during an accident and may result in decreased worker exposure.

Contamination Limits as Applied to Spent Fuel and High Level Waste (HLW) Packages. No options have been identified for this issue. The issue was included in the proposed rule in response to Commission direction in SRM-SECY-00-0117. NRC is seeking input on whether the Agency should address this issue in future rulemaking activities. As a result, no regulatory options were developed in this document and no regulatory analysis conducted.

Modification of Event Reporting Requirements. The preferred option is Option 2. Option 2 revises § 71.95 to require that the licensee and certificate holder jointly submit a written report for the criteria in new subparagraphs (a)(1) and (a)(2). The NRC also will add new paragraphs ©) and (d) to § 71.95 which will provide guidance on the content of these written reports. The NRC also would update the submission location for the written reports from the Director, Office of Nuclear Material Safety and Safeguards to the NRC Document Control Desk. Additionally, the NRC will remove the specific location for submission of written reports from § 71.95©) and instead require that reports be submitted in accordance with § 71.1. Lastly, the NRC will reduce the regulatory burden for licensees by lengthening the report submission period from 30 to 60 days. Adoption of the conforming change to Part 71 for event reporting requirements (see Section 3.4.8) will result in an increase in regulatory efficiency within NRC. There will be a one-time implementation cost for licensees for revising procedures and for training. Additionally, licensees will benefit due to a reduction in the recurring annual reporting burden as a result of reducing the efforts associated with reporting events of little or no risk or safety significance. It is anticipated that the NRC's recurring annual review efforts for telephone notifications and written reports will not be significantly reduced.

ABBREVIATIONS

ANI	Authorized Nuclear Inspector
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
Bq	Becquerel
CFR	Code of Federal Regulations
Ci	Curie
CoC	Certificate of Compliance
CRP	Coordinated Research Project
CSI	Criticality Safety Index
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
g	Gram
GSA	U.S. General Services Administration
HLW	High Level Waste
IAEA	International Atomic Energy Agency
ICC	Interstate Commerce Commission
INEEL	Idaho National Engineering and Environmental Laboratory
ISFSI	Independent Spent Fuel Storage Installation
LDM	Low Dispersible Material
LSA-III	Low Specific Activity
MOU	Memorandum of Understanding
NMSS	U.S. NRC Office of Nuclear Material Safety and Safeguards
NON	Notice of Non-compliance
NORM	Naturally Occurring Radioactive Material
NOV	Notice of Violation
NRC	U.S. Nuclear Regulatory Commission
NUREG	Nuclear Regulatory Publication
ORNL	Oak Ridge National Laboratory
PE	Licensed Professional Engineer
PGE	Portland General Electric
PRM	Petition for Rulemaking
QA	Quality Assurance
Rem	Roentgen Equivalent Man
SI	Systeme` Internationale
SMAC	Shipment Mobility/Accountability Collection
SSC	Systems, Structures, and Components
Sv	Sievert
TI	Transport Index
TS-R-1	IAEA Safe Transportation Standards
μCi/g	Microcuries per gram
UF_6	Uranium Hexafluoride
U.S.	United States
USEC	United States Enrichment Company

1. Introduction

The U.S. Nuclear Regulatory Commission (NRC or Commission) initiated this rulemaking to: (1) harmonize its transportation regulations found in 10 CFR Part 71 with the most recent transportation standards established by the International Atomic Energy Agency (IAEA) in TS-R-1 and the U.S. DOT's regulations at 49 CFR; and (2) address the Commission's goals for risk-informed regulations and eliminating inconsistencies with other regulatory approaches.

This document presents NRC's Regulatory Analysis of the regulatory options considered by NRC. The purpose of this regulatory analysis is to evaluate the costs and benefits associated with the regulatory changes considered by NRC. Although no statutory mandates exist for the NRC to conduct regulatory analyses, the Commission voluntarily began performing these types of studies in 1976 to ensure that all regulatory burdens will achieve intended regulatory objectives with minimal impacts to licensees. Hence, the NRC considers the regulatory analysis process an integral part of its statutory mission to ensure the protection of public health and safety, property, environmental quality, and national defense and security from civilian uses of nuclear materials.

The remainder of the introduction is divided into two sections. Section 1.1 provides background information on the history, extent, and relationship of this problem; and Section 1.2 states the objectives of the rulemaking.

1.1 Background

As part of its mission to regulate the domestic use of byproduct, source, and special nuclear materials to ensure adequate protection of health and safety and the environment, NRC is responsible for controlling the transport of radioactive materials. NRC shares responsibility for radioactive material transport with the U.S. Department of Transportation (DOT). DOT's regulations in 49 CFR Parts 171 through 180 (often called the "Hazmat Regulations") address packaging, shipper and carrier responsibilities, documentation, and radioactivity limits. In contrast, NRC's regulations are primarily concerned with special packaging requirements for large quantities of radioactive materials. A Memorandum of Understanding (MOU) published July 2, 1979 (44 FR 38690) specifies the roles of DOT and NRC in the regulation of the transportation of radioactive materials. The MOU outlines that DOT is responsible for regulating safety in transportation of all hazardous materials, including radioactive materials, whereas the NRC is responsible for regulating safety in receipt, possession, use, and transfer of byproduct, source, and special nuclear materials. This joint regulatory system protects health and safety and the environment by setting performance standards for the packages and by setting limits on the radioactive contents and radiation levels for packages and vehicles.

On June 28, 2000, the Commission directed the staff in SRM-SECY-00-0117 to both use an enhanced-public-participation process (web site and facilitated public meetings) to solicit public input in the 10 CFR Part 71 rulemaking; and also to publish, for public comment, the staff's Part 71 issue paper in the *Federal Register* (65 FR 44360, July 17, 2000). The issue paper discussed the NRC's plan to revise 10 CFR Part 71 and provided a summary of the changes being considered, both IAEA-related changes and Non-IAEA changes. The NRC published the Part 71 issue paper to begin an enhanced public-participation process designed to solicit public input on the Part 71 upcoming changes. In addition to publication of the issue paper, this process included establishing an interactive web site and holding three facilitated public meetings: a “roundtable” workshop with invited stakeholders and the general public at the NRC Headquarters, Rockville, MD, on August 10, 2000, and two “townhall” meetings, one in Atlanta, GA, on September 20, 2000, and one in Oakland, CA, on September 26, 2000.

SRM-SECY-00-0117 also directed the staff to proceed, after completion of the public meetings, to develop a proposed rule for submittal to the Commission by March 1, 2001. Oral and written comments received from the public and invited stakeholders in the public meetings, and written comments received in response to the issue paper by mail, and electronic comments received on the NRC web site, were considered in preparing the draft Regulatory and Environmental Analyses as well as a comment summary document.

These draft analyses were finalized in 2002 and were used by NRC to develop the proposed rulemaking, the precursor to this final rule. This rulemaking was published in the *Federal Register* on April 30, 2002 (67 FR 21390). Its goals continued to be revising 10 CFR Part 71 to make it compatible with the International Atomic Energy Agency (IAEA) safety standards, Series No. TS-R-1, Regulations for the Safe Transport of Radioactive Material, as well as to promulgate other NRC-initiated requirements. In support of this proposed rulemaking, NRC held two public meetings. One was a “townhall meeting” and it was held in Chicago, IL on June 4, 2002. The second was a “roundtable” workshop with invited stakeholders and the general public at the NRC Headquarters, Rockville, MD, on June 24, 2002.

IAEA Transportation Standards

Before NRC and DOT began regulating the transportation of radioactive materials, the Interstate Commerce Commission (ICC) established the first regulations governing the safe shipment of radioactive materials during the 1950s.[1] In 1961, partially based on regulations similar to those of the ICC, IAEA adopted regulations for the transport of radioactive materials. The IAEA recommended that these regulations, which appeared in Safety Series No. 6 (SS-6), be adopted by Member States and international transport organizations. After the initial harmonization of international and U.S. standards with the IAEA regulations, four comprehensive revisions to SS-6 were published in 1964, 1967, 1973, and 1985.

The revision of the IAEA transport regulations in 1967 led to the revision of the DOT Hazmat Regulations in 1968. This revision also was the basis for a major revision to the NRC’s transport regulations. In 1973, additional revisions were made to the international regulations to include a new system for classifying radionuclides. DOT and NRC adopted these revisions in 1983. In 1985, the IAEA issued a comprehensive revision of SS-6 that was later reprinted in 1990 with minor revisions.[2]

In 1995 (60 FR 50248, September 28, 1995), the NRC published a final rule amending the regulations in 10 CFR Part 71 in order to conform with the 1985 (as amended in 1990) revision of the IAEA transportation standards. The IAEA has since published a revised version of its regulations, “Regulations for the Safe Transport of Radioactive Materials,” 1996 Edition, No.

[1] Grella, A. “Summary of the Regulations Governing Transport of Radioactive Materials in the USA.” *RAMTRANS*, Volume 9, No. 4, pp. 279-292 (1999).

[2] Ibid.

ST-1, in December 1996. The designation of ST-1 was changed, along with minor revisions to the document, to TS-R-1 in June 2000. NRC is currently working to harmonize 10 CFR Part 71 with the latest IAEA TS-R-1 transportation standards. At the same time, NRC is considering additional Part 71 changes to address other issues that have come up during the course of implementing the existing regulations.

On October 19, 1998, the Commission decided in SRM-SECY-98-168 to promulgate a rule to conform 10 CFR Part 71 with TS-R-1. Accordingly, the NRC staff prepared a draft rulemaking plan to be supported by a Regulatory Analysis and an Environmental Assessment.

Fissile Material Shipments and Exemptions

Included within 10 CFR Part 71 are criteria that allow (1) exemptions from classification as a fissile material package and (2) general licenses for fissile material shipments.[3] Specifically, the regulations for fissile material exemptions are provided in § 71.53 and the regulations for general licenses are provided in §§ 71.18, 71.20, 71.22, and 71.24. The exemptions and general licenses pertaining to requirements for packaging, preparation of shipments, transportation of licensed materials, and NRC approval of packaging and shipping procedures have not been significantly altered since their initial promulgation. Available knowledge of radioactive material transport and historic practice have indicated that little or no regulatory oversight is needed for the packaging or transport of certain quantities of fissile material that meet the criteria established in 10 CFR Part 71. Therefore, the fissile material exemptions and general license provisions allow licensees to make shipments without first seeking approval from the NRC.

Before February 1997, § 71.53(d) exempted fissile material from the requirements in §§ 71.55 and 71.59,[4] provided the package did not contain more than five grams of fissile material in any ten-liter (610-cubic inch) volume. The fissile exemptions appearing in 10 CFR 71.53 provide inherent criticality control for all practical cases in which fissile materials existed at or below the applicable regulatory limits (i.e., independent calculations would generally not be expected nor required). Thus, the fissile exemptions did not generally place limits on either the types of moderating/reflecting material present in fissile exempt packages or the number of fissile exempt packages that could be shipped in a single consignment. Also, these exemptions did not require the assignment of a transport index (TI) for criticality control.[5]

In February 1997, the NRC completed an emergency final rulemaking (62 FR 5907, February 10, 1997) to address newly encountered situations regarding the potential for inadequate

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[3] Section 71.4 currently defines fissile material as: "Plutonium-238, plutonium-239, plutonium-241, uranium-233, uranium-235, or any combination of these radionuclides. Unirradiated natural uranium and depleted uranium that has been irradiated in thermal reactors only are not included in this definition. Certain exclusions from fissile material controls are provided in § 71.53."

[4] These sections place additional requirements on fissile packages and shipments to preclude criticality.

[5] Transport index is defined in 10 CFR 71.4 as: "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." See 10 CFR 71.4 for calculation criteria.

criticality safety in certain shipments of exempted quantities of fissile material (beryllium oxide containing a low-concentration of highly-enriched uranium). The emergency rule revised portions of 10 CFR Part 71 that limited the consignment mass for fissile material exemptions and restricted the presence of beryllium, deuterium, and graphite moderators.[6] Subsequent to its release, the NRC solicited public comments on the emergency rule. Five fuel cycle facility licensees and two other interested parties responded with comments that supported the need for the emergency rule but questioned whether some of the new restrictions were excessive. For example, some commenters noted that they had not encountered any problems shipping wastes that would have violated the emergency rule. Others stated that the new restrictions would at least double the number of waste shipments, thereby increasing costs, decreasing worker safety, and increasing the risk of accidents.

Based on these public comments and other relevant concerns, the NRC decided that further assessment was required, including a comprehensive assessment of all exemptions, general licenses, and other requirements pertaining to any fissile material shipment (i.e., not just fissile material shipments addressed by the emergency rulemaking). The NRC contracted Oak Ridge National Laboratory (ORNL) to conduct the assessment, and ORNL reviewed 10 CFR Part 71 (as modified by the emergency rule) in its entirety to assess its adequacy relative to the technical basis for assuring criticality safety. The results of the ORNL study were published as NUREG/CR-5342.[7] ORNL indicated that 10 CFR Part 71 needs updating, particularly to provide a simpler and more straightforward interpretation of the restrictions and criteria set in the regulations.

Based on the findings contained in NUREG/CR-5342, the NRC found it appropriate to evaluate the revisions to 10 CFR Part 71, with the objectives of:

- simplifying the regulations applicable to licensees shipping fissile materials;
- relaxing restrictions on fissile material packages and shipments that are not justified based on plausible criticality concerns; and
- adequately addressing criticality safety for a number of newly considered plausible transportation and packaging situations.

In addition to the changes described above, the NRC has determined that there are other actions that can be taken efficiently as part of one rulemaking package. These other changes, which relate to several different SECY papers and a petition-for-rulemaking (PRM), include the following:

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[6] For purposes of this report, the term "consignment mass" means the amount of fissile material offered by a consignor to a carrier for transport to a new location.

[7] NUREG/CR-5342, "Assessment and Recommendations for Fissile-Material Packaging Exemptions and General Licenses Within 10 CFR Part 71," Oak Ridge National Laboratory, July 1998.

Packaging and Transportation

- SECY-97-161: Major on-going activities include: (1) a limited re-evaluation of the Commission's generic environmental impact statement on transportation (NUREG-0170) to address the impact of spent fuel shipments to a repository or central interim storage facility; (2) a joint DOT/NRC initiative to revise the IAEA process for adopting transportation regulations; and (3) development of standard review plans for both spent fuel and non-spent fuel applications.

- PRM-71-12 (International Energy Consultants): The petitioner requested that the NRC amend its regulations governing shipments of high-level waste under Part 71. The petitioner requested that paragraph 71.63(b), special requirements for plutonium shipments, be deleted in their entirety. This petition will be resolved as part of this rulemaking.

Other Regulations

- SECY-99-174: The objective is to revise 10 CFR 50.59 and 10 CFR 72.48 to clearly define those licensee procedural changes, tests, and experiments for which prior approval is required by the NRC.

- SECY-99-130: The objective is to expand the applicability of Part 71 to holders of, and applicants for, certificates of compliance (and also their contractors and subcontractors).

- SECY-99-100: The objective is to address commitments made by the Commission staff in SECY-98-138 to develop and implement a framework for risk-informed regulations in the Office of Nuclear Material Safety and Safeguards (NMSS).

- SECY-00-0117: The objective is to discuss the current IAEA standards for package surface removable contamination.

- SECY-00-0093: The objective is to review the reporting requirements contained in SECY-00-0093 to determine applicability to Part 71.

- Special Package Approval: The objective is to evaluate the need for revision to the current requirements for approval of special packages based on staff experience with recent exemption requests.

- Adoption of ASME Code: The objective is to evaluate the need for adoption into regulations of portions of the ASME code based on staff experience with spent fuel cask fabricators.

1.2 Objectives of the Final Rule

The objectives of the final rule are to both (1) harmonize NRC's transportation regulations with other regulatory agencies (DOT, IAEA), and (2) implement other NRC-initiated changes in order to simplify the regulations applicable to licensees shipping radioactive materials, while maintaining adequate protection of public health, safety, and the environment.

2. Identification of Alternative Regulatory Options

NRC considered 19 changes to its radioactive material transportation regulations. The first 11 changes were related to harmonizing the radioactive transportation regulations in 10 CFR Part 71 with the IAEA standards from "Regulations for the Safe Transport of Radioactive Materials," 1996 Edition, No. ST-1. The remaining eight changes were regulatory modifications that could be considered by NRC to reduce paperwork and burden for licensees, while maintaining protection of public health, safety, and the environment. (In addition, one of these 19 changes [Section 2.2.5] was based in part on the specific recommendations presented in NUREG/CR-5342.)

For each of the 19 changes, this Regulatory Analysis considers two regulatory options. Option 1 is the No-Action Alternative. Option 2 is based in part on TS-R-1, Safe Transportation Standards. The discussion that follows assumes a familiarity with and understanding of TS-R-1. Option 2 also is based on Commission direction for staff to evaluate additional changes to reduce regulatory burden on licensees.

For the changes to fissile material license provisions, Option 2 is based in part on the specific recommendations presented in NUREG/CR-5342. Due to the complexity of the technical basis for the various recommendations posed in NUREG/CR-5342, this Regulatory Analysis does not provide a detailed description of either the rationale for each recommendation or how the recommendation would be implemented in regulatory text (except where doing so is relatively simple). Consequently, the discussion assumes a familiarity with and understanding of NUREG/CR-5342.

The changes considered in this rulemaking are summarized in Table 2-1 below and are described in more detail in the sections that follow.

Table 2-1. List and Summary Description of Changes Considered to 10 CFR Part 71

Technical Issue	Summary Description of Considered Requirements
IAEA-related changes	
1. Changing Part 71 to the International System of Units (SI) Only	Require the use of SI units exclusively in shipping papers and labels.
2. Radionuclide Exemption Values	Adopt IAEA's radionuclide-specific exemption values for some or all radionuclides.
3. Revision of A_1 and A_2	Change the A_1 and A_2 values promulgated in 10 CFR Part 71, and in standard review plans and guidance documents pertaining to 10 CFR Part 71, to the new values published in TS-R-1.
4. Uranium Hexafluoride Package Requirements	Incorporate the TS-R-1 language into Part 71.
5. Introduction of the Criticality Safety Index Requirements	The action would require labels indicating both the CSI and Transport Index (TI) for fissile material shipments.

Table 2-1. List and Summary Description of Changes Considered to 10 CFR Part 71 (Continued)

Technical Issue	Summary Description of Considered Requirements
6. Type C Packages and Low Dispersible Material	Incorporate provisions from TS-R-1 for Type C packages and low dispersible radioactive material.
7. Deep Immersion Test	Modify the requirements to state that a package for radioactive contents greater than 10^5 A_2 shall be designed to withstand an external water pressure of 2 MPa (290 psi) for a period of not less than one hour without collapse, buckling, or inleakage of water.
8. Grandfathering Previously Approved Packages	Modify Part 71 to subject all packages to regulations in place at the time a Certificate of Compliance was issued. The revised regulations would apply to all new packages, and existing packages after renewal of the Certificate of Compliance.
9. Changes to various definitions	Add a number of definitions to 10 CFR 71.4 to ensure compatibility with TS-R-1.
10. Crush test for fissile material package design	Require crush test for fissile material package designs regardless of package activity.
11. Fissile Material Package Designs for Transport by Aircraft	Subject shipped-by-air fissile material packages with quantities greater than excepted amounts to additional criticality evaluation.
NRC-Initiated changes	
12. Special Package Authorizations	Incorporate requirements into Part 71 that address shipment of special packages and the demonstrated level of safety.
13. Expansion of Part 71 Quality Assurance Requirements to Certificate of Compliance (CoC) Holders	Subject cask certificate holders and applicants for a CoC to the requirements of Part 71.
14. Adoption of ASME Code	Adopt the American Society of Mechanical Engineers Boiler and Pressure Vessel (ASME B&PV) Code Section III, Division 3, for spent fuel transportation casks in Part 71.
15. Change Authority	Incorporate a new subpart in Part 71 that would allow licensees to make minimal changes to their packaging and transportation procedures, without license amendments (for dual purpose casks only).
16. Fissile Material Exemptions and General License Provisions	Modify Part 71 in numerous ways, as needed, to implement some or all of the 17 recommendations contained in NUREG/CR-5342.
17. Double Containment of Plutonium (PRM-71-12)	Remove the 10 CFR 71.63(b) requirements for plutonium shipments. Plutonium packaging requirements would be handled no differently than requirements for other nuclear material (i.e., the A_1/A_2 system), except that plutonium shipped in the U.S. would be shipped as a solid when the shipment's contents contain greater than 0.74 TBq (20 Ci) of plutonium.
18. Contamination Limits as Applied to Spent Fuel and High Level Waste (HLW) Packages	For information only. No regulatory action taken. No regulatory analysis performed.
19. Modifications of Event Reporting Requirements	Conform Part 71 to the revised requirements in Part 50 (65 FR 63769) for event notification.

2.1 Actions to Harmonize NRC Transportation Regulations with IAEA Safe Transport Standards

2.1.1 Changing Part 71 to the International System of Units (SI) Only

TS-R-1 uses the SI units exclusively. This change is stated in TS-R-1, Annex II, page 199. TS-R-1 also requires that activity values entered on shipping papers and displayed on package labels be expressed only in SI units (paragraphs 543 and 549). Safety Series No. 6, the TS-R-1 predecessor, used SI units as the primary controlling units, with subsidiary units in parentheses (Safety Series 6, Appendix II, page 97), and either units were permissible on labels and shipping papers (paragraphs 442 and 447).

On August 10, 1988, Congress passed the Omnibus Trade and Competitiveness Act (the Act), which amended the Metric Conversion Act of 1975. Section 5164 of the Act designates the metric system[8] as the preferred system of weights and measures for U.S. trade and commerce. Congress noted that use of the metric system would improve the competitive position of U.S. products in international markets because world trade is increasingly conducted in metric units. In an effort to have an orderly change to metric units, the Act also requires that all Federal agencies convert to the metric system of measurement in their procurements, grants, and other business-related activities by the end of fiscal year 1992, unless this was impractical or likely to cause significant efficiencies or loss of markets to U.S. firms.

In order to implement the Congressional designation of the metric system as the preferred system of weights and measures for U.S. trade and commerce, Presidential Executive Order 12770 of July 25, 1991, designated the Secretary of Commerce to direct and coordinate metric conversion efforts by all Federal departments and agencies. Executive Order 12770 also directed all executive branch departments and agencies of the U.S. Government to establish an effective process for a policy-level and program-level review of potential exceptions to metric usage. The transition to use of metric units in Government publications would be made as publications are revised on normal schedules or new publications are developed, or as metric publications are required in support of metric usage.

In response to the Act and Executive Order 12770, as well as concerns of certain NRC licensees and other interested parties, NRC, on February 10, 1992, issued a proposed policy statement on metrication for public comment (57 FR 4891). After reviewing public comments, the NRC issued its policy on metrication on October 7, 1992 (57 FR 46202). The metrication policy stated that, after three years, the NRC was to assess the state of metric use by the licensed nuclear industry in the United States to determine whether the metrication policy should be modified.

In accordance with the NRC's policy statement of October 7, 1992, the NRC issued a request for public comment on its existing metrication policy on September 27, 1995 (60 FR 49928).

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[8] The term "metric system" refers to the International System of Units as established by the General Conference of Weights and Measures in 1960 as interpreted or modified for the U.S. by the Secretary of Commerce.

After contacting various industrial, standards, and governmental organizations to determine their view of the policy and reviewing comments submitted in response to the request for public comment, the NRC issued its final Statement of Policy on Conversion to the Metric System on June 19, 1996 (61 FR 31169). The NRC considers its metrication policy to be final, and its conversion to the metric system complete.

Metrication Policy

The metrication policy, which affects NRC licensees and applicants, was designed to allow for response to market forces in determining the extent and timing for the use of the metric system of measurement. The policy also affects the Commission in that the NRC will adhere to the Federal Acquisition Regulations and the General Service Administration (GSA) metrication program for its own purchases.

The NRC's metrication policy commits the Commission to work with licensees and applicants and with national, international, professional, and industry standards-setting bodies (e.g., ANSI, ASTM, ASME) to ensure metric-compatible regulations and regulatory guidance. Through its metrication policy, the NRC encourages its licensees and applicants to employ the metric system of measurement wherever and whenever its use is not potentially detrimental to public health and safety or is uneconomic. The NRC did not want to make metrication mandatory by rulemaking because no corresponding improvement in public health and safety would result, but rather, costs would be incurred without benefit. As a result, there is a mix of licensees and applicants using both the metric and the customary systems of measurement.[9]

According to the NRC's metrication policy, the following documents should be published in dual units (beginning January 7, 1993):

- new regulations
- major amendments to existing regulations
- regulatory guides
- NUREG-series documents
- policy statements
- information notices
- generic letters
- bulletins
- all written communications directed to the public

The metrication policy also states that, in dual-unit documents, the first unit presented will be in the International System of Units with the customary unit shown in parenthesis. In addition, documents specific to a licensee, such as inspection reports and docketed material dealing with a particular licensee, will be in the system of units employed by the licensee.

It should be noted that, currently, NRC requires shipping papers and labels to be completed according to DOT regulations in 49 CFR Part 172. In its regulations, DOT requires the use of SI units, or SI units followed by customary units, both in 49 CFR 172.203(d)(4) and in

[9] Based on telephone conversations with Mr. Felix Killar, NEI on August 30, 1999 and Ms. Lynette Hendricks, NEI on August 31, 1999.

49 CFR 172.403(g)(2). (One exception is that for certain fissile materials, the weight in grams or kilograms may be used instead of activities.)

Option 1: No-Action Alternative

The No-Action Alternative (Option 1) would not modify Part 71 regarding the use of SI units exclusively. With this option, the NRC adheres to its policy of dual units.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC would amend Part 71 to make it compatible with TS-R-1 by requiring the use of SI units only. This would mean requiring a single system of units for both domestic and international shipments.

2.1.2 Radionuclide Exemption Values

NRC currently uses one specific activity limit for exemption of any type of radionuclide from its packaging and transportation regulations. Specifically, 10 CFR 71.10(a) states "[a] licensee is exempt from all requirements of this part with respect to shipment or carriage of a package containing radioactive material having a specific activity not greater than 70 Bq/g (0.002 μCi/g)." Similarly, DOT regulations in 49 CFR 173.403 define radioactive material as "any material having a specific activity greater than 70 Bq/g (0.002 μCi/g)."

TS-R-1, Table I, has been revised to include new, radionuclide-specific values for exempt materials. The IAEA activity concentrations for exempt material range from 1×10^{-1} to 1×10^{7} Bq/g. TS-R-1 also provides a formula to be used to determine the exemption of mixtures of radionuclides. The radionuclide-specific concentration limits are based on IAEA's Basic Safety Standards No. 115 (SS-115, entitled "International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources"), which applies to those natural materials or ores that are part of the nuclear fuel cycle or that will be processed in order to use their radioactive properties.

The general principles for the IAEA exemptions are:

- The radiation risks to individuals caused by the exempted practice or source be sufficiently low as to be of no regulatory concern;

- The collective radiological impact of the exempted practice or source is sufficiently low as not to warrant regulatory control under the prevailing circumstances; and

- The exempted practices and sources are inherently safe, with no appreciable likelihood of scenarios that could lead to a failure to meet the first two criteria.

IAEA exemption values have been derived in SS-115 on the following basis:

- An individual effective dose of 10 μSv per year for normal conditions;
- A collective dose of 1 person-Sv per year of practice for normal conditions;
- An individual effective dose of 1 mSv for accidental conditions; and

- An individual dose to the skin of 50 mSv for both normal and accidental conditions.

These levels were derived for SS-115 using scenarios that did not explicitly address the transport of radioactive material. Additional derivations were performed by IAEA for transport-specific scenarios, and the results were found to be similar to those in SS-115. Therefore, the exemption levels of SS-115 were adopted in TS-R-1.

The nature of the change makes it difficult to quantify the values or impacts. The most significant impact would be on shippers of materials which are not currently subject to the regulations (i.e., less than 70 Bq/g) and which would become subject to them (for example, NORM [Naturally Occurring Radioactive Materials] in natural ores and minerals, or piping, drilling equipment, or drilling waste products from the oil & gas industry). There is no known reliable information on the nature and amounts of materials which would be so affected.

This change would conform Part 71 to DOT's recommended change in its proposed rule. To determine whether Part 71 amendments are appropriate, the following two alternatives were considered:

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), NRC would continue to use one specific activity limit for exemption of any type of radionuclide.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC would adopt, in 10 CFR Part 71, IAEA's radionuclide-specific exemption values for all radionuclides.

2.1.3 Revision of A_1 and A_2

TS-R-1 includes numerous revisions to the individual A_1 and A_2 values for radionuclides. The A_1 and A_2 values are used for determining what type of package must be used for the transportation of radioactive material. The A_1 values are the maximum activity of special form material allowed in a Type A package. The A_2 values are the maximum activity of "other than special" form material allowed in a Type A package. A_1 and A_2 values also are used for several other packaging limits throughout TS-R-1, such as specifying Type B package activity leakage limits, low-specific activity limits, and excepted package contents limits.

The basic radiological criteria for determining A_1 and A_2 values are:

- The effective or committed effective dose to a person exposed in the vicinity of a transport package following an accident should not exceed a reference dose of 50 mSv (5 rem).

- The dose or committed equivalent dose received by individual organs, including the skin, of a person involved in the accident should not exceed 0.5 Sv (50 rem), or in the special case of the lens of the eye, 0.15 Sv (15 rem). A person is unlikely to remain at 1 m from the damaged package for more than 30 minutes.

The IAEA revised A_1 and A_2 values in TS-R-1 based on an analysis technique that includes improved dosimetric models that use the Q System (see Appendix A for the values contained in TS-R-1). The Q System includes consideration of a broader range of specific exposure pathways than the earlier A_1 and A_2 calculations. The five Q models are for external photon dose, external beta dose, inhalation dose, skin and ingestion dose due to contamination transfer, and dose from submersion in gaseous isotopes. The value of A_1 is determined from the most restrictive of the photon and beta doses, and the value of A_2 is determined from the most restrictive of the A_1 value and remaining Q model values.

The impact of these analyses is that the radionuclides have now been subjected to a more realistic assessment concerning exposure to an individual should a Type A transport package of radioactive material encounter an accident condition during transport. The new A_1 and A_2 values reflect that assessment.

During the enhanced public participation process, commenters requested that NRC and DOT retain the current exceptions of A_1 and A_2 for two radionuclides - ^{99}Mo and ^{252}Cf.

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), NRC would retain the current A_1 and A_2 values promulgated in 10 CFR Part 71.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC would revise Part 71 to incorporate the TS-R-1 A_1 and A_2 values maintaining the current exceptions for ^{252}Cf and ^{99}Mo.

2.1.4 Uranium Hexafluoride (UF_6) Package Requirements

Uranium hexafluoride is generated as a result of uranium processing to prepare enriched uranium for use in nuclear power plants. Natural uranium ore is mined and milled to produce an intermediate product known as yellow cake. Yellow cake is then converted into UF_6. This UF_6 is sent to an enrichment facility in Paducah, Kentucky to increase the relative abundance of the fissile isotope ^{235}U from its natural abundance of 0.711 percent by weight to greater than one percent. It is then sent to another enrichment plant in Portsmouth, Ohio where it is further enriched. The enriched UF_6 is then sent to private fuel fabricators where it is converted to uranium oxide for use in nuclear power plants. Both of the existing enrichment facilities (in Portsmouth and Paducah) are run by the United States Enrichment Corporation (USEC), and produce depleted UF_6 as a waste. This depleted UF_6, which contains less than the natural abundance of ^{235}U, is stored in large cylinders in outdoor storage yards. Additionally, DOE operates the K-25 site at Oak Ridge, Tennessee, which in the past had been an enrichment facility and at which there also are cylinders of depleted UF_6 stored in outdoor yards. Depleted UF_6 is usually stored in Type 48 cylinders, while enriched UF_6 is transported in smaller Type 30 cylinders with overpacks.[10] Type 48 cylinders, which can contain either 10 or 14 short tons, are

[10] Overpacks are enclosures used by a single consigner to provide protection or convenience in handling a package or to consolidate two or more packages.

usually 9 to 12 feet long and 4 feet in diameter, while the Type 30 cylinders, which can contain 2.5 short tons, are usually about 7 feet long and 2.5 feet in diameter. Smaller amounts of UF_6 are occasionally shipped in smaller cylinders, such as for laboratory analysis. These smaller cylinders are usually overpacked.

The enrichment facility in Paducah receives about seven Type 48 cylinders a day of UF_6 from the private conversion facilities.[11] Because the UF_6 leaving Paducah and destined for Portsmouth is enriched, it is typically sent in Type 30 cylinders that are overpacked. As reported in the *Cost Analysis Report for the Long Term Management of Depleted Uranium Hexafluoride*, the stockpiles of depleted UF_6 cylinders at the USEC and DOE sites are extensive: Paducah had 28,351 cylinders, Portsmouth had 13,388 cylinders, and K-25 had 4,683 cylinders as of May 1997. In addition, between the two operating sites, approximately 2,000 and 2,500 new cylinders are generated per year for storage. DOE recently issued a record of decision outlining the plan for future management of these cylinders,[12] which involves building at least one conversion facility at either Paducah or Portsmouth to convert the depleted UF_6 back to uranium oxide, which is a more stable form. Another possibility being considered is that a conversion facility will be built at both of these sites.

Current regulation of UF_6 packaging and transportation is a combination of NRC and DOT requirements. The DOT regulations contain provisions which govern many aspects of packaging and shipment preparation, including a requirement that the material be packaged in cylinders that meet the ANSI N14.1 standard. The NRC regulates fissile and Type B packaging designs for all materials, including the fissile UF_6.

Previous editions of the IAEA regulations did not specifically address UF_6 , but TS-R-1 contains detailed requirements for UF_6 packages designed for more than 0.1 Kg UF_6. First, TS-R-1 requires the use of an international standard, ISO 7195 Packaging of Uranium Hexafluoride for Transport, instead of the ANSI N14.1 standard, with the condition that approval by all countries involved in the shipment is obtained (i.e., multilateral approval, (Para 629)). Second, TS-R-1 requires that all packages containing more than 0.1 kg UF_6 must meet the "normal conditions of transport" drop test, a minimum internal pressure test, and the hypothetical accident condition thermal test (Para 630). [However, TS-R-1 does allow a competent national authority to waive certain design requirements, including the thermal test for packages designed to contain greater than 9,000 kg UF_6 , provided that multilateral approval is obtained.] Third, TS-R-1 prohibits packages from utilizing pressure relief devices (Para 631). Fourth, TS-R-1 includes a new exception for UF_6 packages, regarding the evaluation of a single package. The new provision (Para 677(b)) allows UF_6 packages to be evaluated without considering the in-leakage of water into the containment system. This provision means that a single fissile UF_6 package does not have to be subcritical assuming that water leaks into the containment system. This provision only applies when: (1) there is no contact of the cylinder under hypothetical accident tests and the valve remains leak-tight, and (2) when there is a high degree of quality control in the manufacture, maintenance, and repair of packagings coupled with tests to demonstrate closure of each package before each shipment.

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[11] Personal communication with Randy Reynolds, Bectel Jacobs Energy Systems, September, 1998.

[12] U.S. Department of Energy, "Record of Decision for Long-Term Management and Use of Depleted Uranium Hexafluoride," http://web.ead.anl.gov/uranium/new/index.cfm, As of August 3, 1999.

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), NRC would not modify Part 71 to incorporate the TS-R-1 UF_6 requirements.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC would revise Part 71 to incorporate the TS-R-1 UF_6 packaging requirement by promulgating new § 71.55(g), while restricting use of the exception to a maximum enrichment of five weight percent ^{235}U. NRC would, however, add a condition to § 71.55(g) to restrict the use of the exception to a maximum enrichment of five weight percent ^{235}U. The other changes that would need to be made to adopt TS-R-1 (i.e., adoption of ISO 7195, the requirement for packages containing more than 0.1kg UF_6 to meet the normal drop test, pressure test, and thermal test, and the requirement that UF_6 packages not use pressure relief devices) fall under the scope of DOT regulations and, therefore, are not encompassed in NRC's changes to Part 71.

2.1.5 Introduction of the Criticality Safety Index Requirements

In current NRC and DOT regulations, the Transport Index (TI) is defined as follows:

> *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 (mSv) 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.*

TS-R-1 has a requirement (paragraphs 541, 544, and 545) that a Criticality Safety Index (CSI) (paragraph 218), as well as the TI, be posted on packages of fissile material. The CSI assigned to a package, overpack, or freight container containing fissile material shall mean a number that is used to provide control over the accumulation of such containers containing fissile material. Previously, the IAEA regulations used a TI that used one number to accommodate both radiological safety and criticality safety.

The CSI for packages would be determined by using a formula provided by TS-R-1, which is the same as the formula for the TI for criticality control purposes found in NRC and DOT regulations. The CSI for each consignment would be determined as the sum of the CSIs of all the packages in that consignment. In addition, TS-R-1 states that the CSI of any package or overpack should not exceed 50, except for exclusive use consignments.

In order to make NRC regulations consistent with TS-R-1, a definition for CSI would have to be added, and the CSI component would need to be removed from the current definition of TI.

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), NRC would not require labels or modify definitions for CSI and would retain the current TI label requirement.

Option 2: Amendment to 10 CFR Part 71

Under Option 2, NRC would revise 10 CFR Part 71 to include a definition of CSI for fissile material packages and revise the existing TI definition.

2.1.6 Type C Packages and Low Dispersible Material

Analogous to a Type B package, IAEA has devised the concept of a Type C package that could withstand severe accident conditions in air transport without loss of containment or increase in external radiation (see TS-R-1 paragraphs 230, 667-670, 730, and 734-737). However, the design-basis accident conditions are somewhat different.

- One of the potential post-crash environments that a Type C package is more likely to see than a Type B package is burial. If a package whose contents generate heat becomes buried, an increase in package temperature and internal pressure could result. Therefore, Type C packages are required to meet heat-up and corrosion tests to which Type B packages are not subject.

- Type C packages are more likely to end up in deep water after an accident, so all Type C packages, no matter the design curie content, are required to undergo deep immersion testing.

- Puncture/tearing tests are required to account for the possibility of rigid parts of the air craft damaging the package.

- Since aircraft carry much more fuel than trucks, Type C packages are subjected for 60 minutes to a thermal test similar to the 30-minute Type B package test.

- Since aircraft travel at higher speeds than surface vehicles, the impact test is done at 90 m/s.

- Tests for Type C packages are not sequential because of the velocities and the space involved in aircraft accidents reduce the likelihood of a cask receiving high levels of multiple stresses.

U.S. regulations have no Type C package requirements, but have specific requirements for the air transport of plutonium. In addition to meeting Type B package requirements, to be certified for the air transport of plutonium, a package must withstand:

- an impact velocity of 129 m/sec;
- a compressive load of 31,800 kg;
- impact of a 227 kg dropped weight (small packages);
- impact of a structural steel angle falling from a height of 46 m;
- a 60-minute fire;
- a terminal velocity impact test; and
- deep submersion to 4 MPa (600 lbs/in^2).

The Type C package tests in IAEA's TS-R-1 are less rigorous than the U.S. tests for air transport of plutonium.

The LDM has limited radiation hazard and low dispersibility; as such, it could continue to be transported by aircraft in Type B packages (i.e., LDM is excepted from the TS-R-1 Type C package requirements). The LDM specification was added in TS-R-1 to account for radioactive materials (package contents) that have inherently limited dispersibility, solubility, and external radiation levels. The test requirements for LDM to demonstrate limited dispersibility and leachability are a subset of the Type C package requirements (90-m/s impact and 60-minute thermal test) with an added solubility test, and must be performed on the material without packaging. The LDM also must have an external radiation level below 10 mSv/hr (1 rem/hr) at 3 meters. Specific acceptance criteria are established for evaluating the performance of the material during and after the tests (less than 100 A_2 in gaseous or particulate form of less than 100-mm aerodynamic equivalent diameter and less than 100 A_2 in solution). These stringent performance and acceptance requirements are intended to ensure that these materials can continue to be transported safely in Type B packages aboard aircraft.

<u>Option 1: No-Action Alternative</u>

Under the No-Action Alternative (Option 1), NRC would not adopt Type C packages or the "low dispersible radioactive material" concepts into 10 CFR Part 71.

<u>Option 2: Amendments to 10 CFR Part 71</u>

Under Option 2, NRC would revise 10 CFR Part 71 to incorporate the Type C Package and low dispersible radioactive material concepts for air transportation but retain § 71.74, the accident conditions for air transport of plutonium.

2.1.7 Deep Immersion Test

The NRC currently requires a deep immersion test for some packages of irradiated nuclear fuel. This requirement is contained in 10 CFR 71.61 and states that "a package for irradiated nuclear fuel with activity greater than 37 PBq (10^6 Ci) must be so designed that its undamaged containment system can withstand an external water pressure of 2 MPa (290 psi) for a period of not less than one hour without collapse, buckling, or inleakage of water."

The revised IAEA requirement in TS-R-1 (paragraphs 657 and 730) no longer specifically states that it applies only to packages of irradiated fuel, but instead applies to all Type B(U) and B(M) packages containing more than 10^5 A_2, as well as Type C packages. In addition, TS-R-1 states only that the containment system can not fail, and does not require that the containment system not buckle or allow inleakage of water. ST-2 (para. 730.3) states that some degree of buckling or deformation is acceptable provided that there is no rupture. ST-2 (para. 657.5) also states that it is recognized that leakage into and out of the package is possible, and the aim is to ensure that only dissolved activity is released.

This expansion in the types of materials required to meet this requirement in TS-R-1 was due to the fact that radioactive materials, such as plutonium and high-level radioactive wastes, are increasingly being transported by sea in large quantities. The threshold defining a large quantity as a multiple of A_2 is considered to be a more appropriate criterion to cover all radioactive materials, and is based on a consideration of radiation exposure as a result of an accident.

The pressure requirement of 2 MPa (which is equivalent to 200 m of water submersion) corresponds approximately to the continental shelf and the depths where some studies indicated that radiological impacts could be important. Recovery of a package from this depth would be possible and salvage would be facilitated if the containment system did not rupture.

Currently, there are no Type C packages licensed for use in the U.S. If a Type C package design was developed and certified, it would need to pass the enhanced deep immersion test. Type C packages are addressed further in Section 2.1.6.

<u>Option 1: No-Action Alternative</u>

Under Option 1, the No-Action Alternative, NRC would not require design of a package with radioactive contents greater than 10^5 A_2 or irradiated nuclear fuel with activity greater than 37 PBq to withstand external water pressure of 2 MPa for a period of one hour or more without rupture of the system.

<u>Option 2: Amendments to 10 CFR Part 71</u>

Under Option 2, the NRC would revise Part 71 to require an enhanced water immersion test for packages used for radioactive contents with activity greater than 10^5 A_2. Section 71.61 currently refers to packages for irradiated fuel with activity greater than 37 PBq (10^6 Ci); the water immersion test would need to be changed to apply to Type B packages containing greater than 10^5 A_2 and Type C packages.

2.1.8 Grandfathering Previously Approved Packages

The purpose of grandfathering is to minimize the costs and impacts of implementing changes in the regulations on existing package designs and packagings. Grandfathering typically includes provisions that allow: (1) continued use of existing package designs and packagings already fabricated, although some additional requirements may be imposed; (2) completion of packagings which are in the process of being fabricated or which may be fabricated within a given time period after the regulatory change; and (3) limited modifications to package designs and packagings without the need to demonstrate full compliance with the revised regulations, provided that the modifications do not significantly affect the safety of the package.

TS-R-1 grandfathering provisions (see TS-R-1, paragraphs 816 and 817) are more restrictive than those previously in place in Safety Series 6 (1985) or 1985 (as amended 1990). The primary impact of these two paragraphs is that Safety Series 6 (1967) approved packagings are no longer grandfathered, i.e., cannot be used. The second impact is that fabrication of packagings designed and approved under Safety Series 6 (1985) or 1985 (as amended 1990) must be completed by a specified date.

In TS-R-1, packages approved for use based on Safety Series 6 1973 or 1973 (as amended) can continue to be used through their design life, provided the following conditions are satisfied: multilateral approval is obtained for international shipment, applicable TS-R-1 QA requirements and A_1 and A_2 activity limits are met, and, if applicable, the additional requirements for air transport of fissile material are met. While existing packagings are still authorized for use, no new packagings can be fabricated to this design standard. Changes in the packaging design or content that significantly affect safety require that the package meet current requirements of TS-R-1.

TS-R-1 further states that those packages approved for use based on Safety Series 6 (1985) or 1985 (as amended 1990) may continue to be used until December 31, 2003, provided the following conditions are satisfied: TS-R-1 QA requirements and A_1 and A_2 activity limits are met, and, if applicable, the additional requirements for air transport of fissile material are met. After December 31, 2003, use of these packages for foreign shipments may continue under the additional requirement of multilateral approval. Changes in the packaging design or content that significantly affect safety require that the package meet current requirements of TS-R-1. Additionally, new fabrication of this type packaging must not be started after December 31, 2007. After this date, subsequent package designs must meet TS-R-1 package approval requirements.

<u>Option 1: No-Action Alternative</u>

Under the No-Action Alternative (Option 1), NRC would not adopt the new grandfathering provisions contained in TS-R-1.

<u>Option 2: Amendments to 10 CFR Part 71</u>

Under Option 2, NRC would modify § 71.13 to phase out packages approved under Safety Series 6. This Option would include a 3-year transition period for the grandfathering provision on packages approved under Safety Series 6 (1967). This period will provide industry the opportunity to phase out old packages and phase in new ones. In addition, packages approved under Safety Series 6 (1985) would not be allowed to be fabricated after December 31, 2006.

2.1.9 Changes to Various Definitions

The changes contemplated by NRC in this proposed rulemaking would require changes to various definitions in order to improve consistency with IAEA safe transportation standards contained in TS-R-1.

Option 1: No-Action Alternative

Under the No-Action alternative (Option 1), NRC would not adopt any new definitions, nor modify any existing definitions concurrent with the modifications addressed in the proposed rule.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC proposes to add various definitions to 10 CFR 71.4 and modify existing definitions to both ensure compatibility with definitions found in TS-R-1 and to improve clarity in NRC regulations. Specifically, the proposal would add or modify the following:

- Criticality Safety Index
- Certificate of Compliance
- Department of Transportation
- Deuterium
- A_1
- A_2
- LSA-III
- Fissile Material
- Graphite
- Package
- Spent Nuclear Fuel/Spent Fuel
- Structures, Systems, and Components Important to Safety (SSCs)
- Transport Index

2.1.10 Crush Test for Fissile Material Package Design

IAEA's TS-R-1 broadened the crush test requirements to apply to fissile material package designs (regardless of package activity). [IAEA Safety Series 6 and Part 71 have previously required the crush test for certain Type B packages.] This was done in recognition that the crush environment was a potential accident force which should be protected against for both radiological safety purposes (packages containing more than 1,000 A_2 in normal form) and criticality safety purposes (fissile material package design).

Under requirements for packages containing fissile material, TS-R-1 682(b) requires tests specified in paragraphs 719-724 followed by whichever of the following is the more limiting: (1) the tests specified in paragraph 727(b) (drop test onto a bar) and, either paragraph 727©) (crush test) for packages having a mass not greater than 500 kg and an overall density not greater than 1,000 kg/m^3 based on external dimensions, or paragraph 727(a) (nine meter drop test) for all other packages; or (2) the test specified in paragraph 729 (water immersion test).

Safety Series 6 (paragraph 548) required and 10 CFR Part 71 (71.73) presently requires the crush test for packages: (1) having a mass not greater than 500 kg and an overall density not greater than 1,000 kg/m^3 based on external dimensions; and (2) radioactive contents greater than 1000 A_2 not as special form radioactive material. Under TS-R-1, the radioactive contents greater than 1,000 A_2 criterion has been eliminated for packages containing fissile material. The 1,000 A_2 criterion still applies to Type B packages and also is applied to the IAEA newly created Type C package category.

To be consistent with TS-R-1, the NRC would have to revise 10 CFR Part 71 wording to recognize that the 1,000 A_2 criterion does not apply to fissile material package designs.

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), the NRC would not modify Part 71 to incorporate the crush test requirement for fissile material packages.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, the NRC staff would revise § 71.73©)(2) wording to agree with TS-R-1 and extend the crush test requirement to fissile material package designs.

2.1.11 Fissile Material Package Designs for Transport by Aircraft

The IAEA's TS-R-1 introduced new requirements for fissile material package designs that are intended to be transported aboard aircraft (paragraph 680). TS-R-1 requires that shipped-by-air fissile material packages with quantities greater than excepted amounts (which would include all the NRC certified fissile packages) be subjected to an additional criticality evaluation. Specifically, TS-R-1 paragraph 680 requires that packages must remain subcritical, assuming 20 centimeters of water reflection but not inleakage (i.e., moderation) when subjected to the tests for Type C packages.[13] The specification of no water ingress is given because the objective of this requirement is protection from criticality events resulting from mechanical rearrangement of the geometry of the package (i.e., fast criticality). The provision also states that if a package takes credit for "special features," this package can only be presented for air transport if it is shown that these features remain effective even under the Type C test conditions followed by a water immersion test. "Special features" generally mean features that could prevent water inleakage (and therefore could be taken credit for in criticality analyses) under the hypothetical accident conditions. Special features are permitted under current 10 CFR 71.55©).

[13] The ST-1 imposition of Type C and LDM requirements (see Section 2.1.6) were in recognition that severe aircraft accidents could result in forces exceeding those of the "accident conditions of transport" that are imposed on Type B and fissile package designs. Since the hypothetical accident conditions for Type B packages are the same as those applied to package designs for fissile material, there also was a need to consider how these more severe test conditions should be applied to fissile package designs transported by air.

The application of the para 680 requirement to fissile-by-air packages is in addition to the normal condition tests (and possibly accident tests) that the package already must meet. Thus:

- Type A fissile package by air must:

  (A) Withstand incident-free conditions of transport with respect to release, shielding, and maintaining subcriticality (single package and 5xN array),

  (B) Withstand accident condition tests with respect to maintaining subcriticality (single package and 2xN array), and

  ©) Comply with para 680 with respect to maintaining subcriticality (single package).

- Type B fissile package by air must:

  (A) Withstand incident-free conditions of transport <u>and</u> Type B tests with respect to release, shielding, and maintaining subcriticality (single package and 5xN array/normal and 2xN array/accident), and

  (B) Comply with para 680 with respect to maintaining subcriticality. (single package)

- Type C fissile material package must withstand:

  (A) Incident-free conditions of transport (single package and 5xN array), Type B tests (single package and 2xN array), and Type C tests (single package) with respect to release, shielding, and maintaining subcriticality.

The draft advisory material for the IAEA transport regulations (ST-2) indicates that the requirement "... is provided to preclude a rapid approach to criticality that may arise from potential geometrical changes in a single package..." ST-2 also indicates that "...Where the condition of the package following the tests cannot be demonstrated, worst case assumptions regarding the geometric arrangement of the package and contents should be made taking into account all moderating and structural components of the packaging."

There are no provisions in TS-R-1 for "grandfathering" fissile material package designs which will be transported by air. TS-R-1 paragraphs 816 and 817 state that these packages are not allowed to be grandfathered. Consequently, all fissile package designs intended to be transported by aircraft would have to be evaluated prior to their use.

<u>Option 1: No-Action Alternative</u>

Under the No-Action Alternative (Option 1), the NRC would not modify Part 71 to incorporate the TS-R-1 requirements contained in paragraph 680.

<u>Option 2: Amendments to 10 CFR Part 71</u>

Under Option 2, the NRC would include only the salient text from new TS-R-1, Paragraph 680 for an additional criticality evaluation, in a new paragraph 71.55(f), that only applies to air transport.

2.2 NRC-Specific Changes

2.2.1 Special Package Authorizations

IAEA's TS-R-1 establishes procedures for demonstrating the level of safety for shipment of packages under special arrangements. Paragraphs 312 and 824 through 826 of TS-R-1 address approval of shipments under special arrangement and are provided verbatim below:

> *312. Consignments for which conformity with the other provisions of these regulations is impracticable shall not be transported except under special arrangement. Provided the competent authority is satisfied that conformity with the other provisions of the regulations is impracticable and that the requisite standards of safety established by these regulations have been demonstrated through means alternative to the other provisions, the competent authority may approve special arrangement transport operations for a single or a planned series of multiple consignments. The overall level of safety in transport shall at least be equivalent to that which would be provided if all the applicable requirements had been met. For international consignments of this type, multilateral approval shall be required.*
>
> *824. Each consignment transported internationally under special arrangement shall require multilateral approval.*
>
> *825. An application for approval of shipments under special arrangement shall include all the information necessary to satisfy the competent authority that the overall level of safety in transport is at least equivalent to that which would be provided if all the applicable requirements of these Regulations had been met. The application shall also include:*
>
> *A statement of the respects in which, and of the reasons why, the consignment cannot be made in full accordance with the applicable requirements; and*
>
> *A statement of any special precautions or special administrative or operational controls which are to be employed during transport to compensate for the failure to meet the applicable requirements.*
>
> *826. Upon approval of shipments under special arrangement, the competent authority shall issue an approval certificate.*

A Memorandum of Understanding (MOU) published July 2, 1979 (44 FR 38690) specifies the roles of DOT and NRC in the regulation of the transportation of radioactive materials. The MOU outlines that DOT is responsible for regulating safety in transportation of all hazardous materials, including radioactive materials, whereas the NRC is responsible for regulating safety in receipt, possession, use, and transfer of byproduct, source, and special nuclear materials. Thus, DOT serves the role of U.S. Competent National Authority and NRC certifies packages for domestic transport of radioactive material. Consequently, a shipper of radioactive materials must first obtain an NRC Certificate of Compliance for the package. Before the package may be exported, the shipper must apply for and receive a competent authority certificate from DOT.

According to statistics compiled by the Nuclear Energy Institute, 31 states have operating nuclear reactors with a total of 103 operating reactors. After a nuclear power plant is closed and removed from service it must be decommissioned. As explained in NUREG-1628, *Staff Responses to Frequently Asked Questions Concerning Decommissioning of Nuclear Power Reactors*, decommissioning a nuclear power plant requires the licensee to reduce radioactive material on site. This effort to terminate the NRC license entails removal and disposal of all radioactive components and materials at each site, including the reactor.

Current NRC practice is to grant exemptions for package approval on special arrangement shipments, as the Commission did for the Portland General Electric (PGE) Trojan Reactor Vessel. 10 CFR 71.8 states:

> *On application of any interested person or on its own initiative, the Commission may grant any exemption from the requirements of the regulations in this part that it determines is authorized by law and will not endanger the life or property nor the common defense and security.*

In October 1998, the NRC staff used this provision to grant a request for approval from PGE to transport the Trojan reactor vessel to a disposal site at the Hanford Nuclear Reservation near Richland, Washington. Specifically, PGE was exempted from 10 CFR 71.71©)(7), which requires transport packages to be capable of surviving a 30-foot drop, and 71.73©)(1), which requires the integrity of transport packages to be tested by a one-foot drop onto a flat, unyielding surface prior to shipment. PGE requested these exemptions in order to ship the reactor vessel and internals via barge and land transport to the disposal facility. This scenario was preferred to the alternative separate disposal of the reactor vessel and internals because it resulted in lower radiation exposures to the general public and workers, a shortened decommissioning schedule, and lower overall costs.

Although approval of designs for packages to be used for the transportation of licensed materials qualifies for a categorical exclusion, the exception from preparing an environmental assessment or an environmental impact statement (10 CFR 51.22©)(13)) does not apply to NRC packages authorized under an exemption. Consequently, the Trojan shipment was authorized for transport only after an Environmental Assessment and Finding of No Significant Impact had been published in the *Federal Register*. Additionally, PGE was required to apply for an exemption from DOT regulations governing radioactive material shipments that do not recognize packages approved under an NRC exemption.

NUREG-1628 reports that as of January 1998, three NRC-licensed power reactors had completed decommissioning. In addition to the Trojan plant, five other nuclear power reactors are now in various stages of dismantlement and decontamination. Because decommissioning is a condition for obtaining a 40-year NRC nuclear power operating license, further decommissioning efforts of the nuclear power reactors can be anticipated for the future.

<u>Option 1: No-Action Alternative</u>

Under the No-Action Alternative (Option 1), NRC would continue to address approval of special packages using exemptions under 10 CFR 71.8.

<u>Option 2: Amendments to 10 CFR Part 71</u>

Under Option 2, the NRC would incorporate new requirements in 10 CFR Part 71 that address approval for shipment of special packages and that demonstrate an acceptable level of safety. These requirements would be based on paragraph 312 of TS-R-1, but also would address regulatory and environmental conditions and requirements that are characteristic to the nuclear industry in the U.S.

2.2.2 Expansion of Part 71 Quality Assurance Requirements Certificate of Compliance (CoC) Holders

NRC has determined that 10 CFR Part 71 is not clear when addressing the issue of applicability of the regulations contained therein (i.e., who is covered by and must comply with the regulations). In fiscal year 1996, NRC staff identified several instances of nonconformance by CoC Holders and their contractors. Nonconformance was observed in the following areas: design, design control, fabrication, and corrective actions. Due to the fact that these problems are typically addressed under a quality assurance program, the proposed rulemaking focuses on amending regulations in Subpart H of Part 71, Quality Assurance. The regulations contained in Subpart H will explicitly include CoC Holders and CoC applicants. Recordkeeping and reporting requirements for these entities also will be established.

The following citation discusses the applicability of Part 71:

> *10 CFR Part 71.0©) The regulations in this part apply to any licensee authorized by specific or general license issued by the Commission to receive, possess, use, or transfer licensed material, if the licensee delivers that material to a carrier for transport, transports the material outside the site of usage as specified in the NRC license, or transports that material on public highways.*

CoC Holders and CoC applicants appear to be outside the applicability of 10 CFR Part 71.0©). As noted above, the regulations in Part 71 apply only to NRC licensees. CoC Holders are not necessarily NRC licensees. In fact, a CoC Holder must only abide by the requirements of Part 71, Subpart D to obtain a CoC.

Because CoC Holders and CoC applicants would be subject to the regulations contained in 10 CFR Part 71 under the action, they also would be subject to NRC enforcement actions if they fail to comply with the regulations. Currently, CoC Holders and CoC applicants are only subject to administrative Notices of Noncompliance (NONs). Adding these entities to the applicability of Part 71 would allow NRC to issue Notices of Violation (NOVs), which assign graduated severity levels to violations. The issuance of an NOV performs the following functions: (1) conveys to the entity violating the requirement and to the public that a violation of a legally binding requirement has occurred; (2) uses graduated severity levels to convey the severity level of the violation; and (3) shows that NRC has concluded that a potential risk to public health and safety could exist. The evidence gathered to formulate an NOV can then be used to support the issuance of further enforcement sanctions such as NRC orders.

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), NRC would not subject CoC Holders or CoC applicants to the requirements contained in 10 CFR Part 71.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC would explicitly subject CoC Holders and CoC applicants to the requirements contained in 10 CFR Part 71. NRC also would add recordkeeping and reporting requirements for CoC Holders and CoC applicants.

2.2.3 Adoption of ASME Code

Currently, licensees are responsible for implementing and describing a quality assurance (QA) plan as part of the package approval process. The following citation discusses quality assurance:

> *10 CFR Part 71.37(a) The applicant shall describe the quality assurance program [...] for the design, fabrication, assembly, testing, maintenance, repair, modification, and use of the proposed package.*

In addition to licensee QA programs, NRC inspects licensee and licensee contractor operations from time-to-time. NRC inspections of vendor/fabricator shops have uncovered, over the past several years, QA problems with the production of transportation and storage casks. In some instances, QA problems have persisted in spite of repeated NRC deficiency findings. Implementation of the QA provisions set forth in Subpart H of 10 CFR Part 71 is the responsibility of the individual licensees. Because a specific ASME code was not available for spent fuel containers in the past, only portions of various ASME pressure vessel codes were employed in their design and construction. Many QA procedures employed as part of ASME code implementation were therefore not implemented by container designers and fabricators. ASME recently issued "Containment Systems and Transport Packages for Spent Fuel and High Level Radioactive Waste," Boiler and Pressure Vessel Code, Division 3 Section III. Fabricators manufacturing transportation cask containment systems subject to this specific ASME code would therefore be permitted to stamp components. ASME also is developing a code which, if approved, would allow the stamping of the confinement component for storage casks.

Three principal QA activities are employed when conforming to the ASME code:

- Preparation for and passing of an ASME Survey of each shop and field site involved in fabrication;
- Preparation of a Design Report certified by a licensed professional engineer (PE); and
- Introduction of a full-time Authorized Nuclear Inspector (ANI) on site during fabrication.

The most important aspect of the ASME QA program is the on-site presence of the ANI. The ANI is an independent professional capable of reporting QA issues to the management of the licensee/fabricator, and to the NRC. This on-site expert presence would alleviate the need for NRC inspections of licensee and fabrication facilities.

Implementation of the ASME Code would be consistent with the National Technology Transfer and Advancement Act of 1995, Public Law 104-113, Section 12(d), which requires governmental agency adoption of consensus technical standards. Government agencies are required to adopt these standards unless doing so would be inconsistent with other laws or would be impractical to implement. The proposed rule implementing the ASME consensus technical standards will conform to NRC's "Interim Guidance on the Use of Government-Unique and Voluntary Consensus Standards," May 3, 1999.

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), NRC would retain the current QA provisions for the package approval process so that the on-site presence of the ANI would not be required and NRC inspections of licensee and fabrication facilities would continue.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC would adopt the American Society of Mechanical Engineers Boiler and Pressure Vessel (ASME B&PV) Code Section III, Division 3, for spent fuel transportation casks in 10 CFR Part 71. This action would currently apply to spent fuel transportation cask containments. The industry is in the process of revising Division 3 to include storage casks and when re-issued (2 to 5 years), would broaden its current scope to include spent fuel storage canisters and internals, in addition to transportation casks containment and internals. The action also would apply to dual-purpose casks.

2.2.4 Change Authority

Certificate holders and licensees are allowed under § 72.48 to make certain changes to a spent fuel storage cask's design or procedures used with the storage cask and to conduct tests and experiments, without prior NRC review and approval. However, Part 71 does not contain any similar provisions to permit a CoC holder to change the design of a Part 71 transportation package, without prior NRC review and approval. This results in NRC issuing separate CoC's under Parts 71 and 72 for dual-purpose spent fuel storage casks and transportation packages. The entity holding both a Part 71 and Part 72 CoC would be allowed, under Part 72, to make certain changes to the design of a dual-purpose cask (e.g., changes that affect a component or design feature that has a storage function) without obtaining prior NRC approval. This for changes that would not be allowed under Part 71 if that component or feature also has a transportation function. This is a requirement under Part 71 -- i.e., prior NRC review and approval -- even when the same physical component and change are involved -- i.e., the change involves a component that has both storage and transportation functions).

NRC staff recommended that an authority similar to § 72.48 be created for dual-purpose spent fuel storage casks and transportation packages intended for domestic use only. This authority was recommended to be limited to the Part 71 CoC holder. In addition, staff identified other supporting changes to Part 71 that would be required to ensure consistency with the process contained in § 72.48. These changes included: (1) the use of common terminology such as "changes to the cask design, as described in the final safety analysis report" (FSAR); (2) a process for requesting amendments to a CoC; (3) periodic updates by certificate holders to the FSAR for a Type B(DP) package to ensure that an accurate "licensing" basis is available when future proposed changes are evaluated; and (4) a requirement that licensees possess a copy of the FSAR as well as the CoC before making a shipment. Further, any application of "change authority" to Part 71 CoC's would only apply to packages intended for the domestic transport of spent fuel since a change authority is not recognized under IAEA regulations (TSR-1).

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), licensees or cask certificate holders would still be required to gain NRC approval for changes to procedures, or cask designs, through license amendments.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC would revise 10 CFR Part 71 to add a new section regulating dual-purpose spent fuel storage and transportation packages used for domestic transport only. In addition to providing a new process for approving dual purpose transportation packages, the new requirements would provide the authority for CoC holders to make some changes to a dual-purpose package design without prior NRC approval. The section also would include new requirements for submitting and updating a Final Safety Analysis Report (FSAR) describing the package's design.

2.2.5 Fissile Material Exemptions and General License Provisions

Included within 10 CFR Part 71 are criteria that allow exemptions from classification as a fissile material package and general licenses for fissile material shipments:

1. Subpart B – Exemptions
   - Exemption for low-level material (§ 71.10)

2. Subpart C – General Licenses
   - Fissile material, limited quantity per package (§ 71.18)
   - Fissile material, limited moderator per package (§ 71.20)
   - Fissile material, limited quantity, controlled shipment (§ 71.22)
   - Fissile material, limited moderator, controlled shipment (§ 71.24)

3. Subpart E – Package Approval Standards
   - Fissile material exemptions (§ 71.53)

Since their initial promulgation, the exemptions and general licenses pertaining to requirements for packaging, preparation of shipments, transportation of licensed materials, and NRC approval of packaging and shipping procedures have not been significantly altered. Available knowledge on radioactive materials transportation and historic practices confirmed the need for little or no regulatory oversight of packaging or shipment of fissile materials meeting the criteria established in 10 CFR Part 71. The fissile material exemptions and general license provisions allowed licensees to prepare and send shipments of such fissile materials without obtaining specific approval from NRC.

Before February 1997, § 71.53(d) exempted fissile material from the requirements in §§ 71.55 and 71.59, provided the package did not contain more than 5 grams of fissile material in any 10-liter (610-cubic inch) volume. The fissile exemptions appearing in 10 CFR 71.53 were assumed to provide inherent criticality control for all practical cases in which fissile materials existed at or below the applicable regulatory limits (i.e., independent calculations would generally not be expected nor required). Thus, the fissile exemptions did not generally place limits on either the types of moderating/reflecting material present in fissile exempt packages or the number of fissile exempt packages that could be shipped in a single consignment. Also, these exemptions did not require the assignment of a transport index for criticality control.

In February 1997, NRC completed an emergency final rulemaking (62 FR 5907, February 10, 1997) to address newly-encountered situations regarding the potential for inadequate criticality safety in certain shipments of exempted quantities of fissile material (beryllium oxide containing a low-concentration of high-enriched uranium). The emergency rule revised portions of 10 CFR Part 71 that limited the consignment mass for fissile material exemptions and restricted the presence of beryllium, deuterium, and graphite moderators. Subsequent to its release, NRC solicited public comments on the emergency rule. Five NRC fuel cycle facility licensees and two other interested parties responded with comments that supported the need for the emergency rule, but argued that the restrictions imposed therein were excessive. For example, several commenters noted that they had shipped wastes that violated the emergency rule in the past without any problems and that the new restrictions would at least double the number of waste shipments, thereby increasing costs, decreasing worker safety, and increasing the risk of accidents.

Based on these public comments and other relevant concerns, NRC decided that further assessment was required, including a comprehensive assessment of all exemptions, general licenses, and other requirements pertaining to *any* fissile material shipment (i.e., not just fissile material shipments addressed by the emergency rulemaking). NRC contracted Oak Ridge National Laboratory (ORNL) to conduct the assessment, and ORNL reviewed 10 CFR Part 71 (as modified by the emergency rule) in its entirety to assess its adequacy relative to the technical basis for assuring criticality safety. Specifically, ORNL:

- documented perceived deficiencies in the technical or licensing bases that might be incapable of maintaining subcriticality under normal conditions of transport and hypothetical accident conditions;

- identified areas where regulatory wording could cause confusion among licensees and potentially lead to subsequent safety concerns;

- studied and identified the practical aspects of transportation and licensing that could mitigate, justify, or provide a historical basis for any identified potential deficiency; and

- developed recommendations for revising the current regulations to minimize operational and economic impacts on licensees, while maintaining safe practices and correcting licensing deficiencies.

The results of the ORNL study (NUREG/CR-5342) indicated that the fissile material exemptions and general licenses need updating, particularly to provide a simpler and more straightforward interpretation of the restrictions and criteria set in the regulations. The regulatory options are based on the recommendations contained in NUREG/CR-5342.

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), NRC would not modify 10 CFR Part 71 to implement the 17 recommendations contained in NUREG/CR-5342, but would continue to use the modified regulations promulgated under 10 CFR Part 71, RIN 3150-AF58, Fissile Material Shipments and Exemptions, final rule. This alternative involves amendments of regulations for the shipment of exempt quantities of fissile material and the shipment of fissile material under a general license through the restriction of the use of beryllium and other special moderating materials in the shipment of fissile materials and the consignment of limits on fissile exempt shipments.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC would modify the 10 CFR Part 71 regulations to implement 16 of the 17 recommendations contained in NUREG/CR-5342. (Recommendation 6 would not be adopted.)

Table 2-2 presents the recommended changes from NUREG/CR-5342 and pairs each with the NRC recommended regulatory action.

The net effect of adopting these 16 recommendations would be to make the following changes:

- Add language in § 71.14 for an exemption from the other requirements of Part 71 for materials that meet the fissile exemptions in § 71.15.

- Revise § 71.15 to include controls on fissile package mass limit combined with package fissile-to-nonfissile mass ratio.

- Add an exemption in § 71.15 for individual packages containing two grams or less fissile material.

- Create new § 71.22 by consolidating and simplifying current fissile general license provisions from existing §§ 71.18, 71.20, 71.22, and 71.24, revise the mass limits and add Type A, CSI, and QA requirements. The general license would now rely on mass-based limits and the CSI.

- Create new § 71.23 by consolidating the existing general license requirements for plutonium-beryllium sealed sources, which are contained in existing §§ 71.18 and 71.22 into one general license and revise the mass limits.

Table 2-2. Recommendations and Changes Related to Fissile Material Packaging Exemptions and General Licenses

NUREG/CR-5342 Recommendation	Summary of Recommended Action
1. Revise the definitions in § 71.4 and other text in Part 71 (perhaps considering relationships between 49 CFR Part 173 and IAEA No. TS-R-1) to ensure consistency and to clarify any intended distinctions between words/phrases such as: - exemption, exception, and exclusion - manifest, consignment, shipment, and conveyance - consignment, consignor, and shipper - controlled shipment, exclusive use, etc.	Amend definitions and phrases in Part 71 to ensure consistency between Part 71, IAEA safe transportation standards in TS-R-1, and DOT requirements contained in 49 CFR Part 173.
2. Revise the definition of "fissile material" in § 71.4 and other text in Part 71 to (1) eliminate the nuclide ^{238}Pu from the definition, and (2) clarify whether "fissile material" consists of fissile nuclides or of materials containing fissile nuclides.	Amend § 71.4 by revising the definitions of "fissile material," "package," and "transportation index." The definition of "fissile material" would be revised by removing ^{238}PU from the list of fissile nuclides; clarifying that fissile material means the fissile nuclides, not materials containing fissile nuclides, and redesignating the reference to exclusions from the fissile material controls from § 71.53 to new § 71.15. The definition of "package" would be revised by redefining "Type A packages" in accordance with DOT regulations contained in 49 CFR Part 173. The definition of "transport index" (TI) would be revised to provide greater clarity on the two different bases for the TI: radiation safety and criticality safety, and to clarify where equations for calculating the TI are located within the regulations.
3. Revise § 71.15 so that, if the radioactive material contains fissile material, the exemption applies only if the specific activity is not greater than 43 Bq/g.	Amend § 71.15 to exempt radioactive material containing less than 15 grams of fissile material provided the package has at least 200 grams of solid, non-fissile material for every gram of fissile material.
4. Revise the § 71.14(b) exemption so that it does not include fissile material that should meet a packaging requirement.	Revise § 71.14(b) by redesignating the reference to fissile material exemption standards from § 71.53 to new § 71.15.

Table 2-2. Recommendations and Changes Related to Fissile Material Packaging Exemptions and General Licenses (Continued)

NUREG/CR-5342 Recommendation	Summary of Recommended Action
5. Move the § 71.53 fissile material exemptions to Subpart B of Part 71, from Subpart E.	Redesignate § 71.53 as § 71.15 and relocate these requirements to Subpart B with the other Part 71 exemptions. This section also would be amended by adding new paragraphs to provide mass-based limits in classifying fissile material. The concentration or consignment based limits currently described in § 71.53 would be removed with the exception of the 15 gram limit provided a new ratio of fissile to non-fissile material is met. In addition, individual packages containing two grams or less fissile material are exempt.
6. Establish at NRC or DOE a fissile shipment database to help NRC better understand fissile shipments and make more informed regulatory determinations in the future. This recommendation would probably require regulatory changes to either or both of § 71.91 (“Records) and § 71.95 (“Reports”), depending on how shipment information would be obtained.	**Not adopted.** [Add new reporting and recordkeeping requirements to Part 71 to track information pertaining to fissile material shipments.]
7. Create a separate general license for Pu-Be sources, revise the quantity of plutonium allowed to be shipped as Pu-Be neutron sources, and/or provide packaging requirements that prevent challenges to the basis for criticality safety.	Create new § 71.23 to provide regulations on the shipment of Pu-Be special form material, consolidating regulations contained in §§ 71.18 and 71.22. The overall effect of the change would be to permit shipments of Pu-Be sealed sources containing between 24 and 240 grams of fissile Pu on exclusive use shipments. Shipments containing less than 240 grams could be made under the revisions to § 71.22 and on exclusive or non-exclusive use conveyances. Shipment of Pu-Be sealed sources containing greater than 240 grams fissile Pu would be made in Type B packages on an exclusive use conveyance.
8. Simplify the general license provisions and make them consistent with § 71.59 by (1) merging sections addressing general licenses for controlled shipments (§ 71.22 and § 71.24) along with sections addressing general licenses for limited quantity/moderator per package (§ 71.18 and § 71.20), and (2) specifying the aggregate transport index (TI) allowed for non-exclusive use and exclusive use.	Remove §§ 71.22 and 71.24. 10 CFR 71.59 would be revised to use the term “criticality safety index” consistently between §§ 71.59, 71.22 and 71.23. The action also will be revised such that packages shipped under these sections should use the criticality control transport index determined by those sections.

Table 2-2. Recommendations and Changes Related to Fissile Material Packaging Exemptions and General Licenses (Continued)

NUREG/CR-5342 Recommendation	Summary of Recommended Action
9. Revise § 71.20 and § 71.24 to use bounding non-uniform quantities of ^{235}U rather than to distinguish between uniform and non-uniform distributions. Alternatively, add a definition of "non-uniform distribution" that can be clearly interpreted by licensees to § 71.4.	Remove the requirements contained in existing §§ 71.20 and 71.24 and incorporate into the new § 71.22 - General license: Fissile material.
10. Delete/revise § 71.18(e) and § 71.22(e), which address the shipment under general licenses of fissile materials containing Be, C, and D_2O, to remove the Be, C, and D_2O quantity restrictions, except to note that these materials should not be present as a reflector material (limiting the quantity of these materials to 500 grams per package should eliminate any concern relative to their effectiveness as a reflector).	See recommended action for Recommendation 8.
11. Revise the mass control in § 71.18(d) and the mass restriction in § 71.20©)(4) for moderators having a hydrogen density greater than water to apply (only) whenever such high-density hydrogenous moderator exceeds 15 percent of the mass of hydrogenous moderator in the package.	Revise the gram limits for fissile material mixed with material having a hydrogen density greater than water and place them in new Table 71-1.
12. Specify minimum package requirements as provided by § 71.43 and § 71.45 for shipments under the general licenses to help ensure good shipping practices for fissile materials with low specific activity.	Specify that fissile material shipped under the general license provisions of new § 71.22 would be contained in a Type A package.
13. Given the implementation of Recommendation 12, increase the package mass limits allowed by § 71.18 and § 71.20 to provide similar safety equivalence as certified packages defined under §§ 71.55 and 71.59.	See recommended action for Recommendation 12.
14. Revision to mass-limited exemptions. Provide criteria based on a ratio of the mass of fissile material per mass of nonfissile material that is non-combustible, insoluble in water, and not Be, C or D_20. Alternatively, incorporate into existing § 71.53 a conveyance control based on a TI of 100. Given one of the above, remove the restriction on Be, C, and D_2O from existing § 71.53 except for § 71.53(b).	Provide mass-based limits in classifying fissile material. The recommended action would allow for increasing quantities of fissile material to be shipped; however, there would be additional restrictions in the form of ratios of the mass of the fissile material to non-fissile material present in the package. The mass of moderating materials would not be allowed in the mass of the package when calculating the ratio of fissile to non-fissile material.
15. Revise existing §§ 71.53(a), ©), and (d) by deleting restrictions on Be, C, and D_2O.	The current restrictions on Be, C, and D_2O would be removed as licensees would be allowed to us a mass-ratio rather than a mass-limit.

Table 2-2. Recommendations and Changes Related to Fissile Material Packaging Exemptions and General Licenses (Continued)

NUREG/CR-5342 Recommendation	Summary of Recommended Action
16. Revise § 71.53©) by adding the minimum packaging standard at § 71.43 to the exemption for uranyl nitrite solutions transport.	Amend the current requirement to clarify that the nitrogen to uranium atomic ratio for shipments of liquid uranyl nitrate must be greater than or equal to two. Further, a requirement specifying the use of Type A packages would be added.
17. Revise § 71.53(b) by removing the requirement that the fissile material be distributed homogeneously throughout the package contents and that the material not form a lattice arrangement within the package. (Maintain the moderator criteria restricting the mass of Be, C, and D_2O to less than 0.1 percent of the fissile material mass.)	Move and revise the requirement from § 71.53(b) to § 71.15(d) to provide that beryllium, graphite, and hydrogenous material enriched in deuterium, constitute less than five percent of the uranium mass.

2.2.6 Double Containment of Plutonium (PRM-71-12)

NRC's regulations in § 71.63 include the following special requirements for plutonium shipments:

> *§ 71.63 Special requirements for plutonium shipments.*
>
> *(a) Plutonium in excess of 0.74 TBq (20 Ci) per package must be shipped as a solid.*
>
> *(b) Plutonium in excess of 0.74 TBq (20 Ci) per package must be packaged in a separate inner container placed within outer packaging that meets the requirements of Subparts E and F of this part for packaging of material in normal form. If the entire package is subjected to the tests specified in § 71.71 ("Normal conditions of transport"), the separate inner container must not release plutonium as demonstrated to a sensitivity of 10^{-6} A_2/h. If the entire package is subjected to the tests specified in § 71.73 ("Hypothetical accident conditions"), the separate inner container must restrict the loss of plutonium to not more than A_2 in 1 week. Solid plutonium in the following forms is exempt from the requirements of this paragraph:*
>
> *(1) Reactor fuel elements;*
>
> *(2) Metal or metal alloy; and*
>
> *(3) Other plutonium bearing solids that the Commission determines should be exempt from the requirements of this section.*

The NRC received a petition for rulemaking on behalf of International Energy Consultants, Inc. dated September 25, 1997. In this petition, the petitioner requested that § 71.63(b) be deleted. The petitioner believed that provisions stated in this regulation cannot be supported technically or logically. The petitioner stated that based on the "Q-System for the Calculation of A_1 and A_2 Values," an A_2 quantity of any radionuclide has the same potential for damaging the environment and the human species as an A_2 quantity of any other radionuclide. The petitioner further stated that the requirement that a Type B package must be used whenever package content exceeds an A_2 quantity should be applied consistently for any radionuclide. The petitioner believed that if a Type B package is sufficient for a quantity of a radionuclide X which exceeds A_2, then a Type B package should be sufficient for a quantity of radionuclide Y which exceeds A_2, and this should be similarly so for every other radionuclide.

The petitioner stated that while, for the most part, the regulations embrace this simple logical congruence, the congruence fails under § 71.63(b) because packages containing plutonium must include a separate inner container for quantities of plutonium having an activity exceeding 0.74 TBq (20 Ci). The petitioner believed that if the NRC allows this failure of congruence to persist, the regulations will be vulnerable to the following challenges:

> (1) The logical foundation of the adequacy of A_2 values as a proper measure of the potential for damaging the environment and the human species, as set forth under the Q-System, is compromised;

(2) The absence of a radioactivity limit for every radionuclide which, if exceeded, would require a separate inner container, is an inherently inconsistent safety practice; and

(3) The performance requirements for Type B packages as called for by 10 CFR Part 71 establish containment conditions under different levels of package trauma. The satisfaction of these requirements should be a matter of proper design work by the package designer and proper evaluation of the design through regulatory review. The imposition of any specific package design feature such as that contained in 10 CFR 71.63(b) is gratuitous. The regulations are not formulated as package design specifications, nor should they be.

The petitioner believed that the continuing presence of § 71.63(b) engenders excessively high costs in the transport of some radioactive materials without a clearly measurable net safety benefit. The petitioner stated that this is so in part because the ultimate release limits allowed under Part 71 package performance requirements are identical with or without a "separate inner container," and because the presence of a "separate inner container" promotes additional exposures to radiation through the additional handling required for the "separate inner container." The petitioner further stated that "...excessively high costs occur in some transport campaigns," and that one example "... of damage to our national budget is in the transport of transuranic wastes." Because large numbers of transuranic waste drums must be shipped in packages that have a "separate inner container" to comply with the existing rule, the petitioner believed that large savings would accrue without this rule. Therefore, the petitioner believed that elimination of § 71.63(b) would resolve these regulatory "defects."

As a corollary to the primary petition, the petitioner believed that an option to eliminate § 71.63(a) as well as § 71.63(b) also should be considered. This option would have the effect of totally eliminating § 71.63. The petitioner believed that the arguments propounded to support the elimination § 71.63(b) also support the elimination of § 71.63(a).

By letter dated April 30, 1999, the NRC informed the petitioner that it had considered the petition and the public comments and decided to defer final action on the petition. The NRC informed the petitioner of its development of the current Part 71 rulemaking and that the subject matter of the petition and elements of the rulemaking address similar issues, and that resolution of the petition would be conducted with the rulemaking action.

The NRC anticipated in 1974 that a large number of shipments of plutonium nitrate liquids could result from spent nuclear fuel reprocessing and revised its regulations to require that plutonium in excess of 0.74 TBq (20 Ci) be shipped in solid form. The NRC did so because shipment of plutonium liquids is susceptible to leakage (if the shipping package is improperly or not tightly sealed). The value of 0.74 TBq (20 Ci) was chosen because it was equal to a large quantity of plutonium as defined in 10 CFR Part 71 in effect in 1974. Although this definition no longer appears in 10 CFR Part 71, the value as applied to double containment of plutonium has been retained. The concern about leakage of liquids arose because of the potential for a large number of packages (probably of more complex design) to be shipped due to reprocessing and the increased possibility of human error resulting from handling this expanded shipping load.

The NRC treats dispersible plutonium oxide powder in the same way because it also is susceptible to leakage if packages are improperly sealed. Plutonium oxide powder was of particular concern because it was the most likely alternative form (as opposed to plutonium nitrate liquids) for shipment in a fuel reprocessing economy. To address the concern with dispersible powder, the NRC required that plutonium not only must be in solid form, but also that solid plutonium be shipped in packages requiring double containment. Moreover, the NRC stated that the additional inner containment requirements are intended to take into account that the plutonium may be in a respirable form and that solid forms that are essentially nonrespirable, such as reactor fuel elements, are suitable for exemption from the double containment requirement.

The Commission further stated:

> Since the double containment provision compensates for the fact that the plutonium may not be in a "nonrespirable" form, solid forms of plutonium that are essentially nonrespirable should be exempted from the double containment requirement. Therefore, it appears appropriate to exempt from the double containment requirements reactor fuel elements, metal or metal alloy, and other plutonium bearing solids that the commission determines suitable for such exemption. The latter category provides a means for the Commission to evaluate, on a case-by-case basis, requests for exemption of other solid material where the quantity and form of the material permits a determination that double containment is unnecessary.

Placing the 1974 decision in the context of the times, in a document dated June 17, 1974, titled "Environmental Impact Appraisal Concerning Proposed Amendments to 10 CFR Part 71 Pertaining to the Form of Plutonium for Shipment" the following statements were made:

> *Using the present criteria and requirements of Part 71, hundreds of packages containing plutonium nitrate solutions have been shipped with no reported instances of plutonium leaks from the containment vessel.*
>
> *The present situation with respect to the quantity and specific activity (radioactivity per unit mass) of plutonium involved in transportation is expected to change significantly over the next several years. Increasingly large quantities of plutonium shipped and the number of shipments made are expected to increase. For example, the amount of plutonium available for recovery was estimated to be about 500 kg in 1974 as compared to 20,000 kg in 1980. In addition, the specific activity of the plutonium will increase with higher reactor fuel burn-up, resulting in higher gamma and neutron radiation levels, greater heat generation, and greater potential for pressure generation (through radiolysis) in shipping packages containing plutonium nitrate solutions.*
>
> *Because of expected changes in the quantities and characteristics of plutonium to be transported and because of the inherent susceptibility of liquids to leakage, the Commission believes that safety would be enhanced if the physical form of plutonium for shipment was restricted to a solid, except for packages containing less than 20 curies.*

Further, in SECY-R-74-5, dated July 6, 1973, it was acknowledged by NRC that:

> *The arguments for requiring a solid form of plutonium for shipment are largely subjective, in that there is no hard evidence on which to base statistical probabilities or to assess quantitatively the incremental increase in safety which is expected. The discussion in the Regulatory staff paper, SECY-R-702, is not intended to be a technical argument which incontrovertibly leads to the conclusion. It is, rather, a presentation of the rationale which has led the Regulatory staff to its conclusion that a possible problem may develop and that the proposed action is a step towards increasing assurance against the problem developing.*

On November 30, 1993, the DOE petitioned the Commission to amend § 71.63 to add a provision that would specifically remove canisters containing plutonium-bearing vitrified waste from the packaging requirement for double containment. DOE's main arguments were that the canistered vitrified waste provided a comparable level of protection to reactor fuel elements, that the plutonium concentrations in the vitrified waste will be lower than in spent nuclear fuel, and that the vitrified waste is in an essentially nonrespirable form. The Commission published a notice of receipt for the petition, docketed as PRM-71-11, in the *Federal Register* on February 18, 1994, requesting public comment by May 4, 1994. The public comment period was subsequently extended to June 3, 1994, at the request of the Idaho National Engineering and Environmental Laboratory (INEEL) Oversight Program of the State of Idaho.

On June 1, 1995, the NRC staff met with the DOE in a public meeting to discuss the petitioner's request and the possible alternative of requesting an NRC determination under § 71.63(b)(3) to exempt vitrified high level waste from the double containment requirement. The DOE informed the NRC in a letter dated January 25, 1996, of its intent to seek this exemption and the NRC received DOE's request on July 16, 1996. The original petition for rulemaking was requested to be held in abeyance until a decision was reached on the exemption request.

In response to DOE's request, the NRC staff prepared a Commission paper (SECY-96-215, dated October 8, 1996) outlining and requesting Commission approval of the NRC staff's proposed approach for making a determination under § 71.63(b)(3). The determination would have been the first made after the promulgation of the original rule, "Packaging of Radioactive Material for Transport and Transportation of Radioactive Materials Under Certain Conditions," published on June 17, 1974 (39 FR 20960). In a staff requirements memorandum dated October 31, 1996, the Commission disapproved the NRC staff's plan and directed that this policy issue be addressed by rulemaking.

In response, the NRC staff reactivated the DOE petition and developed a proposed rule. On June 15, 1998, the final rule was noticed in the *Federal Register*. In summary, the NRC amended its regulations to add vitrified high level waste, contained in a sealed canister designed to maintain waste containment during handling activities associated with transport, to the forms of plutonium which are exempt from the double containment packaging requirements for transportation of plutonium.

In a October 31, 1996, SRM for SECY-96-215 (dealing with the vitrified waste issue) the Commission directed the staff to "address whether the technical basis for 10 CFR 71.63 remains valid, or whether a revision or elimination of portions of 10 CFR 71.63 is needed to provide flexibility for current and future technologies." In SECY-97-218, dated September 29, 1997, the Commission was informed that "the staff believes the technical bases for 10 CFR 71.63 remain valid and that the provisions provide adequate flexibility for current and future technologies. The staff believes it is desirable to retain those provisions of 10 CFR 71.63 that are not being covered by a separate rulemaking currently underway." The rulemaking underway referred to the DOE petition regarding transport of vitrified high level waste containing plutonium. In the discussion section of SECY-97-218, the staff again admitted that the special provisions (of 10 CFR 71.63) were not based on quantitative evidence of statistical analysis. Instead, subjective arguments regarding experience with shipment and design of packages were used as the basis to support the conclusion.

It should be noted that in press release No. 97-070, dated May 8, 1997, announcing the change in the regulations to allow shipment of plutonium-bearing vitrified waste, the NRC stated:

> *When the existing rule was published, the NRC anticipated that a large number of shipments of plutonium nitrate liquids or plutonium oxide powder could result from spent fuel reprocessing. However, the anticipated large number of shipments has not occurred, because commercial reprocessing is currently not taking place in this country for policy and economic reasons.*

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), NRC would retain the § 71.63 special requirements for plutonium shipments, which would place increased plutonium shipping requirements in the U.S. compared to the IAEA requirements.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC would adopt, in part, the recommended action of PRM-71-12. Specifically, the NRC would remove the double containment requirement of § 71.63(b). However, the NRC would retain the package contents requirement in § 71.63(a) — for shipments whose contents contain greater than 0.74 TBq (20 Ci) of plutonium must be made with the contents in solid form.

2.2.7 Contamination Limits as Applied to Spent Fuel and High Level Waste (HLW) Packages

TS-R-1 contains contamination limits for all packages of 4.0 Bq/cm^2 (22,000 dpm/100 cm^2) for beta and gamma and low toxicity alpha emitting radionuclides, and 0.4 Bq/cm^2 (2,200 dpm/100 cm^2) for all other alpha emitting radionuclides. Although TS-R-1 uses the term "limit," IAEA considers these to be guidance values, or derived limits, above which appropriate action should be considered. In the case of contamination, that action is to decontaminate to within the limits.

TS-R-1 further provides that in transport, "...the magnitude of individual doses, the number of persons exposed, and the likelihood of incurring exposure shall be kept as low as reasonable, economic and social factors being taken into account..." The IAEA contamination regulations have been applied to radioactive material packages in international commerce for almost 40 years and practical experience demonstrates that the regulations can be applied successfully. With respect to contamination limits, TS-R-1 contains no changes from previous versions of IAEA's regulations.

Part 71 does not contain contamination limits, but § 71.87(i) requires that licensees determine that the level of removable contamination on the external surface of each package offered for transport is as low as is reasonably achievable and within the limits specified in DOT regulations in 49 CFR 173.443. The DOT contamination limits differ from TS-R-1 in that the contamination limits apply to the wipe material used to survey the surface of the package, not the surface itself. Also, the contamination limits are only 10 percent of the TS-R-1 values (e.g., wipe limit of 0.4 Bq/cm^2 for beta and gamma and low toxicity alpha emitting radionuclides), because the DOT limits are based on the assumption that the wipe removes 10 percent of the surface contamination. In this regard, the DOT and TS-R-1 limits are equivalent.

The DOT contamination regulations contain an additional provision for which there is no counterpart in TS-R-1. Section 173.443(b) provides that, for packages transported as exclusive use (see 49 CFR 173.403 for exclusive use definition) shipments by rail or public highway only, the removable contamination on any package at any time during transport may not exceed 10 times the contamination limits (e.g., wipe contamination of 4 Bq/cm^2 for beta and gamma and low toxicity alpha emitting radionuclides). In practice, this means that packages transported as exclusive use shipments (this includes spent fuel packages) that meet the contamination limits at shipment departure may have 10 times that contamination upon arrival at the destination. This provision is intended to address a phenomenon known as "cask-weeping," in which surface contamination that is nonremovable at the beginning of a shipment becomes removable during the course of the shipment. Nonremovable contamination is not measurable using wipe surveys and is not subject to the removable contamination limits. At the destination facility, a package exhibiting cask-weeping can exceed the contamination limits by a considerable margin, even though the package met the limits at the originating facility, and was not subjected to any further contamination sources during shipment. Environmental conditions are believed to affect the cask-weeping phenomenon.

The IAEA has plans to establish a Coordinated Research Project (CRP) to review contamination models, approaches to reduce package contamination, strategies to address cask-weeping, and possible recommendations for revisions to the contamination standard that consider risks, costs, and practical experience. IAEA establishes CRPs to facilitate investigation of radioactive material transportation issues by key member States. IAEA will then consider CRP report and any further actions or remedies that may be warranted at periodic meetings.

No regulatory change is proposed at this time. Therefore, no regulatory options have been identified. The above discussion is for information purposes only.

2.2.8 Modifications of Event Reporting Requirements

The current regulations in § 71.95 require that a licensee submit a written report to the NRC within 30 days of three events: (1) a significant decrease in the effectiveness of a packaging while is in use to transport radioactive material, (2) details of any defects with safety significance found after first use of the cask, and (3) failure to comply with conditions of the certificate of compliance (CoC) during use.

The Commission recently issued a final rule to revise the event reporting requirements in 10 CFR Part 50 (see 65 FR 63769). This final rule revised the verbal and written event notification requirements for power reactor licensees in 10 CFR 50.72 and 50.73. In SECY-99-181,[14] NRC staff informed the Commission that public comments on the proposed Part 50 rule had suggested that conforming changes also be made to the event notification requirements in 10 CFR Part 72 (Licensing Requirements for the Independent Storage of Spent Fuel) and 10 CFR Part 73 (Physical Protection of Plants and Material). In response, the Commission directed the NRC staff to study whether conforming changes should be made to Parts 72 and 73. During this study, the NRC staff also reviewed the Part 71 event reporting requirements in 10 CFR 71.95 and concluded that conforming changes should be made to the Part 71 event report requirements. NRC staff also concluded that this proposed rule was the appropriate vehicle to consider such changes.

The NRC staff has identified three principal concerns with the existing requirements in § 71.95. First, the existing requirements only apply to licensees and not to certificate holders. Second, the existing requirements do not contain any direction on the content of these written reports. Third, the Commission recently reduced the reporting burden on reactor licensees in the Part 50 final rule from submitting written reports in 30- to 60-days.

Option 1: No-Action Alternative

Under the No-Action Alternative (Option 1), NRC would not modify § 71.95 and would continue to require that a licensee submit a written report to the NRC within 30 days of three events: (1) a significant decrease in the effectiveness of a packaging while it is in use to transport radioactive material, (2) details of any defects with safety significance found after first use of the cask, and (3) failure to comply with conditions of the certificate of compliance (CoC) during use.

Option 2: Amendments to 10 CFR Part 71

Under Option 2, NRC would revise § 71.95 to require that the licensee and certificate holder jointly submit a written report for the criteria in new subparagraphs (a)(1) and (a)(2). The NRC also would add new paragraphs ©) and (d) to § 71.95 which would provide guidance on the content of these written reports. This new requirement is consistent with the written report requirements for Part 50 and 72 licensees (i.e., §§ 50.73 and 72.75) and the direction from the Commission in SECY-99-181 to consider conforming event notification requirements to the recent changes made to Part 50. The NRC also would update the submission location for the written reports from the Director, Office of Nuclear Material Safety and Safeguards to the NRC Document Control Desk. Additionally, the NRC would remove the specific location for submission of written reports from § 71.95©) and instead require that reports be submitted "in accordance with section 71.1." Lastly, the NRC would reduce the regulatory burden for licensees by lengthening the report submission period from 30- to 60-days.

[14] SECY-99-181, "Proposed Plans and Schedules to Modify Reporting Requirements Other than 10 CFR 50.72 and 50.73 for Power Reactors and Material Licensees;" dated July 9, 1999.

3. Analysis of Values and Impacts

This chapter examines the values and impacts expected to result from implementation of NRC's final rule. It is divided into four main sections. Section 3.1 identifies attributes that are and are not expected to be affected by the rulemaking. Section 3.2 describes how values and impacts were analyzed. Section 3.3 examines the projected values and impacts associated with the actions to harmonize NRC's transportation regulations with the IAEA's latest safety standards. Finally, Section 3.4 examines the projected values and impacts associated with the NRC-specific actions.

NRC's final rule will modify 10 CFR Part 71 to incorporate the IAEA safe transportation standards contained in TS-R-1 and other changes, in addition to the recommendations contained in NUREG/CR-5342. Each of these actions will result in certain values and/or impacts. Thus, the values and impacts of NRC's final rule as a whole consist of the sum of all values and impacts associated with each of the actions. For many of the affected attributes, the values and impacts are expected to be negligible. These values and impacts, therefore, are difficult to estimate, and have not been quantified in this analysis.

3.1 Identification of Affected Attributes

This section identifies and describes the factors within the public and private sectors that the regulatory alternatives (discussed in Section 2) are expected to affect. These factors were classified as "attributes," using the list of attributes provided by NRC in Chapter 5 of its *Regulatory Analysis Technical Evaluation Handbook*.[15] Each attribute listed in Chapter 5 was evaluated, and the basis for selecting those attributes expected to be affected by the action is presented in the balance of this section.

Affected Attributes

- Public Health (Accident) – Changes to radiation exposures to the public, due to changes in accident frequencies and accident consequences, could result from the proposed rule. The regulatory options could both alter the number of shipments (thereby altering accident frequency but not accident probability) and reduce the likelihood of occurrences of criticality (thereby reducing accidental consequences).

- Occupational Health (Accident) – Changes to radiation exposures to workers, due to changes in accident frequencies and accident consequences, could result from the proposed rule. The regulatory options could both alter the number of shipments (thereby altering the accident frequency but not accident probability) and reduce the likelihood of occurrences of criticality (thereby reducing accidental consequences).

- Occupational Health (Routine) – Changes to radiation exposures to workers during normal packaging and transportation operations could result from the proposed rule. The regulatory options could alter the number of packages or shipments, thereby altering the number of workers exposed or the duration of the exposure.

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[15] *Regulatory Analysis Technical Evaluation Handbook*, *Final Report*, NUREG/BR-0184, Office of Nuclear Regulatory Research, January 1997.

- Offsite Property – Effects on offsite property, due to changes in accident frequencies and accident consequences, could result from the action. The regulatory options could both alter the number of shipments (thereby altering the accident frequency but not accident probability) and reduce the likelihood of occurrences of criticality (thereby reducing accidental consequences).

- Onsite Property – Effects on onsite property (direct and indirect), due to changes in accident frequencies and accident consequences, could result from the action. The regulatory options could both alter the number of shipments (thereby altering the accident frequency but not accident probability) and reduce the likelihood of occurrences of criticality (thereby reducing accidental consequences).

- Industry Implementation – The regulatory options would result in implementation costs and savings to industry if industry must evaluate and/or enact changes to ensure that its operating procedures will comply with the actions.

- Industry Operation – The regulatory options would result in industry operation costs and savings to industry if industry must alter its current packaging and shipping procedures to comply with the action.

- NRC Implementation – The regulatory options would result in NRC implementation costs and savings to put the actions into operation. Specifically, NRC would incur implementation costs to revise guidance documents, and where applicable, develop new guidance.

- NRC Operation – The regulatory options would result in NRC operation costs or savings if the number of shipments requiring specific NRC approval changes (e.g., the number of shipments that fail to qualify for the fissile exemption and the general licenses).

- Regulatory Efficiency – The requirements would be expected to result in enhanced regulatory efficiency by clarifying the meaning and applicability of specific terms and requirements, increasing the level of consistency among different regulations, and reducing the potential for noncompliance.

- Environmental Considerations – Effects on the environment, due to changes in accident frequencies and accident consequences, could result from the action. The regulatory options could both alter the number of shipments (thereby altering the accident frequency but not accident probability) and reduce the likelihood of occurrences of criticality (thereby reducing accidental consequences). These environmental effects are being addressed in more detail in the Environmental Assessment being developed in support of the proposed rulemaking.

- Other Government – The regulatory options could affect implementation and operation costs of DOE, to the extent that its material shipments must comply with NRC regulations. The regulatory options also could affect implementation and operation costs of Agreement States if they must enact and implement parallel requirements. The regulatory options would not be expected to affect implementation or operation costs of DOT.

- Improvements in Knowledge – The regulatory options could result in improved data collection that may ultimately result in more robust risk assessments and safety evaluations (i.e., less uncertainty) and, consequently, in improvements in regulatory policy and regulatory requirements.

Attributes *Not* Affected

- Public Health (Routine) – No significant changes are expected with respect to routine radiation exposures to the public. Even if the number of shipments of radioactive materials significantly increases or decreases as a result of the rule, the change in exposure to members of the public as a result of routine shipments would be negligible.

- Safeguards and Security Considerations – The regulatory options, if they alter the costs associated with accepting or downblending weapons-grade uranium from the former Soviet Union, could have some effect on security considerations. The magnitude of this effect is likely to be small, however, due to the U.S. government's role in funding these operations.

- General Public – The action is not expected to have any effects on the general public.

- Antitrust Considerations – The action is not expected to have any antitrust effects.

3.2 Analytical Methodology

This section describes the process used to evaluate values and impacts associated with the regulatory options. The *values* (benefits) of the rule include any desirable changes in affected attributes (e.g., improved public health due to a reduced potential for criticality) while the *impacts* (costs) include any undesirable changes in affected attributes (e.g., increased staff requirements to conduct NRC operations). As described in Section 3.1, the attributes expected to be affected include the following:

- Public Health (Accident)
- Occupational Health (Accident)
- Occupational Health (Routine)
- Offsite Property
- Onsite Property
- Industry Implementation
- Industry Operation
- NRC Implementation
- NRC Operation
- Regulatory Efficiency
- Environmental Considerations
- Other Government
- Improvements in Knowledge

For many of these attributes, the nature or cause of a value or impact is straightforward. For example, values and impacts associated with the attribute "NRC operations" should result from, respectively, either a decrease or increase in the number of NRC staff hours (or other NRC resources) required to oversee the Part 71 requirements on a day-to-day basis. Similarly, values and impacts associated with the attribute "regulatory efficiency" should result from changes to the overall clarity, consistency, or level of consolidation of applicable regulations.

The overall value or impact for some attributes, however, results from the interaction of several influencing factors. For example, a regulatory option that increases the number of packages and/or shipments required of licensees could simultaneously (1) reduce the potential for criticality and (2) increase the potential for routine radiological exposure. In this case, it would be the *net effect* of the influencing factors (i.e., criticality potential and radiological exposure) that would govern whether an overall value or impact would result for several affected attributes, including public health, occupational health, on- and off-site property, and environmental considerations. Similarly, a single regulatory option could affect licensee costs in multiple ways (e.g., it might conceivably increase packaging and shipping costs but decrease costs associated with making transport index calculations).

Ideally, a value-impact analysis quantifies these net effects and calculates the overall values and impacts of each regulatory option. This requires a baseline characterization of the transportation universe, including factors such as the number of licensees affected, the number of shipments and packages affected, the types of packaging used, the transportation method, and the transportation distance. Data availability is a severely limiting factor for the purposes of establishing a baseline characterization of the affected universe.

Data Collection Activities

In support of the development of the value-impact analysis, ICF undertook a significant data collection effort. The first step in the data collection was to determine specific data needs to support the analysis of values and impacts for each of the actions that, in total, make up each of the regulatory options. Specifically, ICF identified the following types of information necessary to develop the value-impact analysis:

Baseline Information

- Number of exempt packages
- Number of non-exempt packages
- Number of exempt shipments
- Number of non-exempt shipments
- Cost per exempt package
- Cost per non-exempt package
- Cost per exempt shipment
- Cost per non-exempt shipment
- Average number of packages per exempt shipments
- Average number of packages per non-exempt shipment

Information for Each Action

- Change in occupational person-rems per year from exposure due to criticality accidents
- Change in public person-rems per year from exposure due to criticality accidents
- Change in occupational person-rems per year from exposure due to traffic accidents
- Change in public person-rems per year from exposure due to traffic accidents
- Change in occupational person-rems per year from routine radiological exposures
- Change in number of exempt packages
- Change in number of non-exempt packages
- Change in number of exempt shipments
- Change in number of non-exempt shipments
- Change in cost per exempt package
- Change in cost per non-exempt package
- Change in cost per exempt shipment
- Change in cost per non-exempt shipment
- Average number of packages per exempt shipment
- Average number of packages per non-exempt shipment
- Cost to clean up and repair criticality accidents
- Cost to clean up and repair traffic accidents
- Change in time required for record-keeping/reporting
- Change in time for regulatory determinations/calculations
- Change in time for regulatory review

ICF conducted numerous searches of existing literature using several databases. For example, ICF reviewed information contained in DOE's Shipment Mobility/Accountability Collection (SMAC) database in an attempt to identify technical information on exempted shipments of fissile materials and fissile material shipments of exempted quantities, or those made under a general license. In addition, extensive searches were conducted via the Internet. Each search was targeted at obtaining specific information related to a change.

Further, for the NUREG/CR-5342 recommendations to change the fissile material requirements, ICF conducted a survey of licensees that currently ship fissile materials to identify the change in the number of packages/shipments and associated costs for each of the actions. ICF, however, received only one survey response. While the information was useful, it did not provide nearly the level of detail necessary to assist the Commission in developing a quantitative value-impact analysis for the actions for fissile materials.

Lastly, the NRC staff, as directed by the Commission, continued to solicit cost-benefit and exposure data from the public and industry to quantify the impact of the proposed Part 71 amendments. The NRC believed this information would assist the Commission in: (1) making and informed decision regarding the proposed IAEA compatibility changes, and (2) avoiding the promulgation of amendments that may result in unforseen and unintended negative impacts, especially in view of the fact that the current regulations in Part 71 have provided adequate protection of the public health and safety. To help focus the public and industry and to capture the most data, the request for information was presented in three groups: (1) General requests that apply to all 19 issues, (2) requests that apply to only IAEA-related changes, and (3) issue-specific staff questions. Table 3-1 describes the specific questions contained in the *Federal Register* Notice for the proposed rule.

Table 3-1. Questions Contained in the
***Federal Register* Notice for the Proposed Rule**

Request for Information on All 19 Issues
The Commission solicited: (1) Quantitative information and data on the costs and benefits which might occur if these proposed changes were adopted; (2) operational data on radiation exposures (increased or reduced) that might result from implementing the Part 71 proposed changes; (3) whether the proposed changes are adequate to protect public health and safety; (4) whether other changes should be considered, including providing cost-benefit and exposure data for these suggested changes; and (5) how should specific risk considerations (i.e., data on what can happen, how likely is it, what are the consequences) be factored into the proposed amendments.
Request for Information on the IAEA-Related Issues (Issues 1-11)
The Commission solicited cost-benefit data to quantify the economic impact of harmonizing with the 11 IAEA changes on the domestic commerce and international commerce of packages containing radioactive material. The NRC is interested in determining: (1) whether the benefits of harmonization with the IAEA standards may exceed the costs, or may result in other health and safety problems resulting from dual standards between domestic (Part 71) and international (TS-R-1) requirements, and (2) whether the NRC should adopt only some of the 11 IAEA changes.
Request for Responses to Issue-Specific Questions
Issue 2--Radionuclide Exemption Values • What impacts, if any, would result for industries that possess, use, or transport materials currently exempt from regulatory control (e.g., unimportant source material under 10 CFR 40.13) if adoption of the radionuclide exemption values were to occur in Part 71? • What impacts, if any, would result for industries that transport natural material and ores containing naturally-occurring radionuclides which are not intended for processing for economic use of their isotopes (e.g., phosphate mining, waste products from the oil and gas industry), if the TS-R-1 exemption values are adopted, but without the “10 times the applicable exemption values” provision? Another possible impact of the proposed radionuclide exemption values is in the area of waste disposal sites which are regulated by EPA under the Resource Conservation and Recovery Act (RCRA). The acceptance limit in these sites for materials containing radioactive residuals is the existing 70 Bq/g (0.002 Ci/g) standard used by DOT, NRC, and EPA. Presently, only the NRC and DOT are proposing to adopt the exemption values, which may result in situations where shipment of materials with residual radioactivity would be allowed for transportation under the new exemption values but would not be allowed for disposal in RCRA sites. • What cost impacts or other problems, if any, would result from adoption of the exemption values, in Part 71 and DOT regulations, for industries or entities involved in the shipment and disposal of materials with residual activity to RCRA sites?

Table 3-1. Questions Contained in the *Federal Register* Notice for the Proposed Rule (Continued)

Issue 3--Revision of A1 and A2
• What impacts, if any, would result for the radiopharmaceutical industry in terms of cost and worker dose by adopting the lower international A2 value, rather than retaining the current A2 value for domestic shipment of molybdenum-99?
• What impacts, if any, would result for industry in terms of cost and worker dose by retaining the current A1 and A2 values for californium-252, rather than adopting the international A1 and A2 values?
• What impacts, if any, would result for industry in terms of cost and worker dose by not including in Table A-1 (A1 and A2 Values for Radionuclides) the 16 radionuclides that are listed in the current Part 71 but not in TS-R-1?
Issue 4--Uranium Hexafluoride UF6 Package Requirements
• Should the current practice of excluding moderators in criticality evaluations for UF6 packages be continued?
Issue 5--Introduction of the Criticality Safety Index Requirements
• What cost or benefit impacts would result if the per package Criticality Safety Index (CSI) were to change from 10 to 50?
Issue 6--Type C Packages and Low Dispersible Material
• NRC requests information on the need for Type C packages, specifically on the number of package designs and the timing of future requests for Type C package design approvals.
Issue 8--Grandfathering Previously Approved Packages
• Under what conditions should packagings be removed from service? • What are the cost or benefit impacts associated with the proposal to remove B( ) packages from service?
Issue 10--Crush Test for Fissile Material Package Design
• What are the cost or benefit impacts of imposing the crush test requirement on fissile material package designs?
Issue 12--Special Package Approval
• What additional limitations, if any, should apply to the conditions under which an applicant could apply for a package authorization?
Issue 17--Double Containment of Plutonium (PRM-71-12)
• What cost or benefit impacts would arise from removal of the double containment requirement for plutonium?

Table 3-1. Questions Contained in the *Federal Register* Notice for the Proposed Rule (Continued)

Issue 18--Contamination Limits as Applied to Spent Fuel and High-Level Waste (HLW) Packages NRC requested information regarding the application of the regulatory limits for removable contamination on the external surfaces of packages used for spent fuel shipments. This information will be most helpful if respondents also indicate the cask design used and whether or not the cask is fitted with a protective cover prior to immersion in the spent fuel pool. Specifically, for previous spent fuel shipments, information was sought on: (1) The removable contamination level on the cask surface after the cask has been loaded, removed from the spent fuel pool, and dried; (2) The dose attributable to any decontamination efforts, including external dose from cask and facility radiation fields and internal dose from airborne radioactivity in the cask handling/loading areas; (3) The removable contamination level on the cask surface after decontamination efforts and before shipment; and (4) The removable contamination levels on the cask surface upon receipt at the destination facility.

To the extent that data were received on these questions, ICF included the data in this regulatory analysis. Appendix B highlights an effort to identify any monetized, quantitative, or qualitative data that were included in the comments received by NRC. The contents of this appendix is *not* a listing of all identified data and should not be viewed as such. This appendix should be used to understand the context of the comments received by NRC.

However, even after directly soliciting for cost-benefit and exposure data to better inform its analyses, NRC did not receive such data on all the issues discussed in this Regulatory Analysis. ICF notes in Sections 3.3 and 3.4 whether or not data were received and if data were received, then these data have been presented and discussed in the appropriate section (e.g., costs to NRC, costs to industry).

3.3 Values and Impacts of Actions to Harmonize 10 CFR Part 71 with IAEA TS-R-1

3.3.1 Changing Part 71 to the International System of Units (SI) Only

Values and Impacts of Option 1

Under the No-Action alternative (Option 1), NRC licensees and applicants would continue to use their preferred system of measurement for completing shipping papers and SI units for completing labels used in the transportation of radioactive materials. Thus, no values or impacts would result from Option 1.

Although an increase in the current number of flawed conversions or accident rates within the U.S. is not expected under Option 1, there would continue to be some instances of confusion, possibly resulting in mishandling or accidents, when packages are received from or shipped to international locations that all use SI units only.

Values and Impacts of Option 2

Under Option 2, NRC would require the use of the International System of Units (SI), also known as the metric system, in shipping papers and labels used in the transportation of radioactive materials. By doing this, the units in shipping papers and labels associated with the packaging and transportation of radioactive materials would be consistent with the units used in the IAEA and guidance documents associated with IAEA.

It should be noted that, currently, NRC requires shipping papers and labels to be completed according to DOT regulations in 49 CFR Part 172. In its regulations, DOT does not specify the unit of measurement in which shipping papers used in the transportation of radioactive materials have to be completed (49 CFR 172.203(d)(4)). Further, DOT regulations do not specify the units of measurement for labels used in the packaging and transportation of radioactive materials (49 CFR 172.403(g)(2)). The following attributes are expected to be affected by adoption of this action:

- Public Health (Accident) – Changes in radiation exposures to the public, due to changes in accident frequencies and accident consequences, could result from the change. The change would require, in some instances, conversion from customary units to SI units in order to satisfy Part 71 reporting requirements. Thus, radiation exposure to the public may change due to possible flawed unit conversions. In addition, the use of SI units only may be a safety issue in an emergency if responders are unfamiliar with the SI system. An estimation of the values/impacts associated with this attribute will be completed in concurrence with the Environmental Assessment being developed in support of this rulemaking.

- Occupational Health (Accident) – Changes in radiation exposures to workers, due to changes in accident frequencies and accident consequences, could result from the change. The change would require, in some instances, conversion from customary units to SI units in order to satisfy Part 71 reporting requirements. Thus, radiation exposure to workers may change due to possible flawed unit conversions. In addition, the use of SI units only may be a safety issue in an emergency if responders are unfamiliar with the SI system. An estimation of the values/impacts associated with this attribute will be completed in concurrence with the Environmental Assessment being developed in support of this rulemaking.

- Offsite Property – Effects on offsite property, due to changes in accident frequencies and accident consequences, could result from the change. The change would require, in some instances, conversion from customary units to SI units in order to satisfy Part 71 reporting requirements. Thus, accident frequencies and offsite property consequences resulting from the occurrence of an accident may increase due to possible flawed unit conversions. An estimation of the values/impacts associated with this attribute will be completed in concurrence with the Environmental Assessment being developed in support of this rulemaking.

- Onsite Property – Effects on onsite property, due to changes in accident frequencies and accident consequences, could result from the change. The change would require, in some instances, conversion from customary units to SI units in order to satisfy Part 71 reporting requirements. Thus, accident frequencies and onsite property consequences resulting from the occurrence of an accident may increase due to possible flawed unit conversions. An estimation of the values/impacts associated with this attribute will be completed in concurrence with the Environmental Assessment being developed in support of this rulemaking.

- Industry Implementation – The change would result in implementation costs to industry sectors currently using customary units (e.g., companies who ship spent fuel, regular fuel, and/or low-specific activity material to destination sites within the U.S.).

- Industry Operation – The change would result in additional operational costs to sectors of industry currently using customary units. These sectors would have to convert from customary units to SI units, altering their current procedures in completing shipping papers and labels used in the packaging and transportation of radioactive materials.

- Other Government – The change could affect implementation and operation costs of Agreement States because they would have to adopt and implement parallel requirements. The change also could affect DOE if it currently submits information in customary units. It is expected, however, that DOE submits data in SI units. In addition, the change could affect DOT's implementation costs, if regulations in 49 CFR 172.202 (shipping papers) were revised to be consistent with this change. However, the change is not expected to affect DOT's operation costs.

- Regulatory Efficiency – The change is expected to result in enhanced regulatory efficiency because the units in shipping papers and labels associated with the packaging and transportation of radioactive materials would be consistent with international standards groups (e.g., IAEA).

- Environmental Considerations -- Effects on the environment, due to changes in accident frequencies and accident consequences, could result from the change. The change would require, in some instances, conversion from customary units to SI units in order to satisfy Part 71 reporting requirements. Thus, effects on the environment could result due to possible flawed unit conversions. In addition, the use of SI units only may be a safety issue in an emergency if responders are unfamiliar with the SI system.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs to Industry

In the U.S., approximately 2.8 million shipments of radioactive materials are made annually by nuclear power reactor licensees and materials licensees.[16] ICF estimates that approximately 70 to 90 percent of these licensees currently use customary units in their daily operations,

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[16] U.S. Department of Transportation, Office of Hazardous Materials Safety, Research and Special Programs Administration, "Hazardous Materials Shipments," October 1998.

including completion of shipping papers and preparation of labels for shipments sent off-site.[17] Thus, the annual number of shipments with shipping papers and labels in Customary units ranges between approximately 1.96 million to 2.52 million.

Licensees who currently complete shipping papers and prepare labels in customary units may have to revise their procedural and administrative activities to convert from customary units to SI units. ICF assumes that unit conversions would be done once, and would be used to complete the shipping paper and label for the corresponding shipment. On average, the time needed to make unit conversions is estimated to be 0.05 hours (or 3 minutes) per shipment.[18] Therefore, at a rate of $77 per hour of professional staff, the annual cost for making unit conversions would range between approximately $7.5 million and $9.7 million per year (see Table 3-2).

Table 3-2. Implementation Costs to Industry Sectors Currently Using Customary Units

Estimate	**Annual number of shipments with shipping papers and labels in customary units (million)**	**Annual cost for licensees converting from customary to SI units ($ million)**
Low	1.96	7.54
High	2.52	9.70

Estimated Costs to Other Government

As noted above, it is expected that DOE already uses SI units. If this were not the case, however, DOE would incur implementation costs for creating a system to convert from customary units to SI units. DOE makes approximately 5,500 shipments of radioactive material per year.[19] Assuming a rate of $77 per hour for professional staff and 0.05 hours per package to make unit conversions (as used above for industry), DOE also could incur costs of up to $21,175 per year.

[17] ICF estimated a lower (70 percent) and upper (90 percent) bound of the number of licensees using Customary units. ICF believes that users of SI units primarily include those licensees involved in international shipments (i.e., exports and/or imports).

[18] Based on best professional judgment.

[19] U.S. Department of Transportation, Office of Hazardous Materials Safety, Research and Special Programs Administration, *Hazardous Materials Shipments*, October 1998.

3.3.2 Radionuclide Exemption Values

Values and Impacts of Option 1

Under the No-Action alternative (Option 1), NRC would continue to use one specific activity limit for exemption of any type of radionuclide. Thus, no values or impacts would result for domestic shipments from Option 1.

Option 1 would keep the current U.S. exemption value of 70 Bq/g (0.002 μCi/g). This would make U.S. standards inconsistent with countries who adopt the international standards. A package being imported into the U.S. carrying an isotope that has an exemption limit greater than 70 Bq/g could be violating U.S. laws. A package being exported from the U.S. carrying an isotope that has an exemption limit less than 70 Bq/g could be in violation of another country's laws. However, since most import/export shipments contain highly purified and/or highly radioactive isotopes, these scenarios would rarely, if ever, occur.

Values and Impacts of Option 2

Under Option 2, NRC would adopt, in 10 CFR Part 71, IAEA's radionuclide-specific exemption values for all materials. The nature of the changes under Option 2 makes it difficult to quantify the values or impacts. Because exempt packages are not subject to the reporting requirements for NRC and DOT-regulated packages, there are no data on the number or frequency of exempt packages shipped in the U.S.

In order to gain some insight into how the changes could affect regulated packages, ICF examined a Sandia report titled "Transport of Radioactive Material in the United States: Results of a Survey to Determine the Magnitude and Characteristics of Domestic, Unclassified Shipments of Radioactive Materials." The values and impacts are summarized below:

- Industry Implementation – Minor administrative and procedural changes would be necessary to provide the framework for operation under radionuclide-specific exemptions.

- Industry Operation – In some cases, shippers would have to expend resources to identify the isotopes in material to ensure that it is exempt instead of verifying that it is less than 70 Bq/g.

- NRC Implementation – Under this option, NRC would incur costs to revise guidance documents and related materials.

- Regulatory Efficiency – Implementing this change would make U.S. regulations more consistent with international regulations. International shipment could be affected by the differences in national regulations.

In addition, Appendix C is included to highlight the specific changes associated with the new exemption values.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

Several commenters responded to NRC's request for cost-benefit and exposure data but no explicit cost data were provided. These commenters statements include the following:

- The proposed rule would burden industry by creating extra and unnecessary costs for bulk shipments of contaminated materials, such as soil or building rubble, or for handling of naturally occurring radioactive materials (NORM).

- Additional enforcement costs would result from implementing the proposed rule and these costs were not discussed.

Estimated Costs to Industry

Based on the information above and the lack of available data, the costs associated with this recommendation have not been quantified, although they are expected to be minimal. These costs are expected to include minor administrative costs and costs to identify specific isotopes in material to verify the specific activity limit.

Moreover, the final rule does not extend NRC regulation of radioactive material. This means that if a material, such as NORM, is not currently subject to NRC regulation, it will not be subject to regulation under the final rule. Also, Part 71 only applies to material licensed by the NRC. Thus if a NORM material were to exceed the exemption values, that material would not be subject to Part 71 because NRC does not regulate NORM. Therefore, no significant additional costs would be borne by industry due to either bulk shipments and or NORM.

Estimated Costs to NRC

NRC would be required to make revisions to guidance documents and related materials. It is estimated that these revisions would take approximately six staff-months to complete. Assuming a cost of $77 per hour for staff, and 20 days per month at 8 hours each, this results in a total cost of approximately $74,000.

NRC understands that the proposed changes will impact enforcement costs. It believes, however, that any additional costs associated with additional enforcement will be (1) minimal but (2) will be offset due to the anticipated benefits of having only one set of shipping requirements, as well as the cost savings that would result from moving some materials outside the scope of regulation.

3.3.3 Revision of A_1 and A_2

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), NRC would retain the current A_1 and A_2 values promulgated in 10 CFR Part 71. Thus, no significant values or impacts would result from Option 1. There would be an impact in that NRC regulations would not be consistent with TS-R-1, but the overall impact of this inconsistency is estimated to be minimal.

Values and Impacts of Option 2

Under Option 2, NRC would revise Part 71 to incorporate the TS-R-1 A_1 and A_2 values, while maintaining the current exceptions for ^{252}Cf and ^{99}Mo.

In general, the new A_1 and A_2 values are within a factor of about three of the earlier values; there are a few radionuclides where the new A_1 and A_2 values are outside this range. Nearly 40 radionuclides have new A_1 values higher than previous values by factors ranging between 10 and 100. This is due mainly to improved modeling for beta emitters. There are no new A_1 or A_2 values that are lower than the previous figures by more than a factor of 10. A few radionuclides previously listed are now excluded but two additional ones have been added, both isomers of ^{150}Eu and ^{236}Np.

In order to gain some insight into how the revisions could affect packages in the U.S., ICF examined a report titled "Transport of Radioactive Material in the United States: Results of a Survey to Determine the Magnitude and Characteristics of Domestic, Unclassified Shipments of Radioactive Materials." A summary of the estimated values and impacts associated with this action is presented below:

- Public Health (Accident) – Changes to radiation exposure to the public due to accident consequences could result from the change. The A_1 and A_2 values were revised by IAEA based on refined modeling of possible doses from radionuclides. It is unclear whether the change for each individual radionuclide would slightly increase or decrease the total risk to public health, but the change to the refined values would be an overall value to public health by ensuring that the A_1 and A_2 values are more precisely based on risk. Analysis of the change showed no significant change in the number of shipments per year; therefore, accident frequency would not be affected.

- Occupational Health (Accident) – Changes to radiation exposure to workers due to accident consequences could result from the change. The A_1 and A_2 values were revised by IAEA based on refined modeling of possible doses from radionuclides. It is unclear whether the change for each individual radionuclide would slightly increase or decrease the total risk to workers, but the change to the refined values would be an overall value to worker health. Analysis of the change showed no significant change in the number of shipments per year; therefore, accident frequency would not be affected.

- Occupational Health (Routine) – Changes to radiation exposure to workers due to normal transportation conditions could result from the change. The A_1 and A_2 values were revised by IAEA based on refined modeling of possible doses from radionuclides. It is unclear whether the change for each individual radionuclide would slightly increase or decrease the total risk to workers, but the change to the refined values would be an overall value to worker health. Analysis of the change showed no significant change in the number of shipments per year; therefore, shipment frequency and routine worker dose would not be affected.

- Industry Implementation – The action could result in implementation costs to industry if industry must revise various aspects of shipping programs or modify shipping processes to assure compliance with the proposed A_1 and A_2 values. However, the cost is expected to be negligible since industry already has programs in place that use A_1 and A_2 values.

- NRC Implementation – The change is expected to result in implementation costs to the NRC to revise the A_1 and A_2 values.

- Other Government – The action could affect implementation and operation costs of DOE to the extent that its shipments must comply with NRC regulations. The action also could affect implementation and operation costs of Agreement States if they must enact and implement parallel requirements. There is not enough available information about the costs to DOE and Agreement States to quantify the resultant impact. The action also would affect the DOT in that DOT A_1 and A_2 values would need to be revised to be consistent with those in Part 71. DOT costs are expected to be similar to those of the NRC.

- Regulatory Efficiency – The action would improve regulatory efficiency by bringing U.S. regulations in compliance with the standards of the IAEA. This would improve the efficiency of handling imports and exports and would make U.S. standards compatible with other IAEA members.

- Environmental Considerations – Effects on the environment due to accident consequences could result from the change. The A_1 and A_2 values were revised by IAEA based on refined modeling of possible doses from radionuclides. It is unclear how the change for each individual radionuclide would affect the total risk to the environment, but the change to the refined values would be an overall value to environmental protection. Analysis of the change showed no significant change in the number of shipments per year; therefore, accident frequency would not be affected.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs to Industry

The proposed action could result in implementation costs should revisions to shipping programs or processes be required. However, the cost is expected to be negligible since industry already has programs in place that use A_1 and A_2 values.

Estimated Costs to NRC

The changes to the A_1 and A_2 values are estimated to require approximately six staff-months of effort. Assuming a cost of $77 per hour for staff, and 20 staff days per month at 8 hours each, this results in a total cost of approximately $74,000. This cost is expected to consist mostly of development costs, such as preparing documents. This estimation of staff time is consistent with that estimated by the NRC during the last revision of the A_1 and A_2 values.

Estimated Costs to Other Government

The changes to the A_1 and A_2 values are estimated to require approximately six staff-months of effort for DOT. Assuming a cost of $77 per hour for staff, and 20 staff days per month at 8 hours each, this results in a total cost of approximately $74,000.

3.3.4 Uranium Hexafluoride (UF_6) Package Requirements

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), the TS-R-1 requirements regarding the packaging of UF_6 would not be included in 10 CFR Part 71. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option 2

Under Option 2, NRC would revise Part 71 to incorporate an exemption from the TS-R-1 UF_6 packaging requirement, which would allow single UF_6 packages to be evaluated for criticality safety without considering leakage of water into the containment system. This exemption is contingent on 1) there being no contact between the valve body and the cylinder under accident tests and the valve remaining water tight, and 2) there being quality controls in the manufacture, maintenance, and repair of the packaging coupled with tests to demonstrate closure of each package before each shipment. To these TS-R-1 requirements, NRC has further limited the scope of the exemption, in new § 71.55(g), by restricting use of the exception to a maximum enrichment of five weight percent ^{235}U.

This change would make Part 71 principally consistent with TS-R-1, enhance NRC regulatory efficiency, and provide a uniform approval basis for designs which are used internationally. The changes clarify the regulations in such a way to clearly demonstrate the performance requirements of UF_6 packages. The changes to the packaging requirements for UF_6 packages will not impact the transport of UF_6, because this section codifies existing practices for UF_6 packages. Consequently, no changes to packages or costs are anticipated from implementing this change to the regulation. The following attribute is likely to be affected by this option:

- Regulatory Efficiency – Under the action, regulatory efficiency is likely to increase as a result of U.S. regulations being consistent with the international community.

Several commenters responded to NRC's request for cost-benefit and exposure data but no explicit cost data were provided. These commenters statements include the following:

- Industry would be precluded from moving to higher enrichment levels due to requirements for special packages, over-packs, increased handling, maximum shipping quantities as well as plants' handling different shipping packages for different enrichment level.

Estimated Costs to Industry

In developing this analysis, it was determined that there would be no cost impacts associated with the adoption of § 71.55(g). That is, most of the impact of adopting the TS-R-1 UF_6 provisions are within the purview of the DOT regulations. Therefore, the adoption of the TS-R-1 requirements are not expected to have significant impact on fissile package designs for UF_6.

Also, industry is not precluded from using higher enrichment levels so long as they can meet the provisions of § 71.55. No costs are associated with this comment because the current enrichment levels are in-line with standard operating practices across the world.

Estimated Costs to NRC

NRC would not incur substantial additional costs from adopting this change.

3.3.5 Introduction of the Criticality Safety Index Requirements

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), NRC would not require labels or modify definitions for CSI. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option 2

Under Option 2, NRC would revise 10 CFR Part 71 to include a definition of CSI for fissile material packages and revise the existing TI definition. The values and impacts are summarized below:

- Public Health (Accident) – Emergency responders would benefit from additional information upon arrival at the accident scene. However, this additional information would only affect their actions in the most severe and unusual accident circumstances.

- Industry Implementation – Minor administrative and procedural changes would be necessary to provide the framework for marking packages for both criticality and radiation.

- Industry Operation – The action would result in additional effort to ensure that packages are marked with both transportation indices.

- NRC Implementation – Under the option, NRC would incur costs to revise guidance documents and related materials.

- Other Government – Emergency responders would have to be notified of the changes to the information on the labels, and references would be provided. In addition, DOE would incur implementation and operation costs in complying with the new requirements.

- Regulatory Efficiency – Implementing this change would make U.S. regulations more consistent with international regulations. International shipment could be affected by the differences in national regulations.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

Several commenters responded to NRC's request for cost-benefit and exposure data but no explicit cost data were provided. The commenters statements were focused on the following:

- Increasing the CSI from 10 to 50 could increase the number of shipments to avoid the staging of the packages at a storage facility incident to transport. This change would effectively remove the exclusive use authorization for multi-modal shipments and would increase the cost of documentation and scheduling in these areas. However, NRC agreed with the commenters and decided to remove the phrase "or stored incident to transport" from the appropriate sections of the final rule and the accompanying documents.

Estimated Costs to Industry

As a result of adopting this change, industry would incur substantial additional costs. Even though approximately 2.8 million shipments of radioactive materials are made annually by nuclear power reactor licensees and materials licensees, NRC expects only a very small number to contain fissile material requiring labels indicating the CSI and TI.[20] Assuming 5,000 of these shipments would be affected, five packages per shipment, and a cost of $1 per package for labeling, the total annual costs to licensees would be approximately $25,000.

Estimated Costs to NRC

NRC would not incur substantial additional costs from adopting this change. Costs are estimated to be less than $1,000 because this change is effectively only a word change from current terminology of "Transport Index for Criticality Control."

Estimated Costs to Other Government

DOE makes approximately 22 fissile material shipments per year.[21] Assuming increased costs of $5 per shipment to comply with the labeling requirement, DOE would incur annual costs of $110.

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[20] U.S. Department of Transportation, Office of Hazardous Materials Safety, Research and Special Programs Administration, "Hazardous Materials Shipments," October 1998.

[21] The estimated annual number of fissile material shipments by DOE is based on the number of such shipments that occurred in fiscal years 1995 and 1996, as reported in DOE's "Transportation Activities Summary Report for Fiscal Years 1995 and 1996."

3.3.6 Type C Packages and Low Dispersible Material

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), NRC would not adopt Type C packages or the "low dispersible radioactive material" concepts into 10 CFR Part 71. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option 2

Under Option 2, NRC would revise 10 CFR Part 71 to incorporate the Type C Packages and low dispersible radioactive material concepts for air transportation but retain § 71.74, the accident conditions for air transport of plutonium. There would be an increase in regulatory efficiency as a result of the nonadoption of the TS-R-1 requirements, which would enhance international shipments. Additional resource costs would be incurred by NRC. Costs also would be incurred by industry. These additional costs to industry would include implementation costs for the design of new packages to meet the Type C requirements rather using existing Type B packages. The following attributes are expected to be affected:

- Public Health (Accident) – The accident risk of air shipments is higher than the accident risk of ground shipments.

- Public Health (Routine) – The public receives lower routine exposures from an air shipment than from an overland shipment. People in their homes and on the highway do not receive measurable exposure from air shipments, and Type C packages would not be carried on passenger aircraft.

- Occupational Health (Routine) – Workers receive additional exposure using air transportation. Although the en route exposure is about the same, air transportation leads to additional handling since the originating and receiving facilities do not have air strips. Packages will normally be trucked to an airport, requiring more loading and unloading than a ground shipment.

- Offsite Property – The consequences to offsite property increase in proportion to the increased radiological accident consequences.

- Industry Implementation – Industry would need to develop and certify Type C packages.

- Industry Operation – DOE was the only user for Type C packages identified. (See Other Government.)

- NRC Implementation – NRC development costs would include such activities as preparation of documents, publishing notices of rulemakings, holding public hearings, and responding to public comments.

- Other Government – Several foreign research reactor spent fuel casks have been shipped by air to port cities and loaded onto a ship for delivery to the U.S. DOE would realize operational cost savings if the aircraft were allowed to fly directly to the U.S.

- Regulatory Efficiency – Under the action, regulatory efficiency is likely to increase as a result of U.S. regulations being consistent with the international community.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs to Industry

As a result of adopting this change, industry would incur substantial additional costs. These costs, however, are not quantifiable without additional information. These additional costs to industry would include costs for the design of new packages to meet the Type C requirements rather using existing Type B packages.

Estimated Costs to NRC

NRC would be required to prepare documents and conduct other activities as a result of the action. It is estimated that these revisions would take approximately two staff-years to complete. Assuming a cost of $77 per hour for staff, and 20 staff days per month at 8 hours each, this results in a total cost of approximately $295,700.

3.3.7 Deep Immersion Test

Values and Impacts of Option 1

Under Option 1, the No-Action Alternative, NRC would not require design of a package with radioactive contents greater than 10^5 A_2 or irradiated nuclear fuel with activity greater than 37 PBq to withstand external water pressure of 2 MPa for a period of one hour or more without rupture of the system. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option 2

Under Option 2, the NRC would revise Part 71 to require an enhanced water immersion test for packages used for radioactive contents with activity greater than 10^5 A_2. The affected attributes are described below:

- Public Health (Accident) – The action may reduce the impact to public health in the case of an accident. The package would be able to withstand the pressure at increased depths without rupturing, thereby keeping the radioactive materials enclosed. The likelihood of a member of the public receiving a dose from a package resting in deep water is exceedingly small and would be even smaller if the action were implemented.

- Occupational Health (Accident) – The action could decrease occupational exposure in the event of an accident in which the package was submersed in water at a depth of less than 200 m (660 ft). The package would be able to withstand the pressure at this depth without rupturing, thereby keeping the radioactive materials enclosed.

- Offsite Property – The action is intended to prevent the containment system from rupturing and possibly releasing radioactive material if a package was lost in deep water. Retaining package integrity would prevent the possible expenses of restricting the area (to prevent users such as boaters or fishers from entering the vicinity) and remediating any contamination of the marine environment.

- Industry Implementation – Implementation of the action could result in costs to licensees as they test and certify packages to the standard.

- NRC Implementation – NRC development costs would include such activities as preparation of documents, publishing notices of rulemakings, holding public hearings, and responding to public comments. It also is anticipated that NRC staff may incur costs for developing procedures, reviewing and approving test results, and recertifying packages.

- NRC Operation – NRC could incur recurring costs to ensure continued compliance with the proposed rule, although these costs are not expected to be significant.

- Other Government – The action could affect implementation and operation costs of the DOE to the extent that its shipments must comply with NRC regulations. There is not enough available information to quantify the resultant costs, but it is expected to be similar to those of industry.

- Regulatory Efficiency – The action would improve regulatory efficiency by bringing U.S. regulations in compliance with the standards of the IAEA. This would improve the efficiency of handling imports and exports and would make U.S. standards compatible with other IAEA members.

- Environmental Considerations – Effects on the environment due to changes in accident consequences could result from the change. The revised testing requirement would prevent the rupture of package containment at deeper depths, thereby preventing possible contamination of the marine environment.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs to Industry

Implementation of the action could result in costs to licensees as they test and certify packages to the standard as well as costs associated with NRC review. However, these costs are anticipated to be relatively small with one of 24 packages undergoing evaluation. This evaluation is estimated to range from $26,700 to $157,500, with the expected total cost to be near $50,600.

Estimated Costs to NRC

NRC would be required to prepare documents and conduct other activities as a result of the action. It is estimated that these revisions would take approximately 150 hours for staff to complete. Assuming a cost of $77 per hour for staff, and 150 staff hours each, this results in a total cost of approximately $11,600.

3.3.8 Grandfathering of Previously Approved Packages

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), NRC would not adopt the new grandfathering provisions contained in TS-R-1. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option 2

Under Option 2, NRC would modify § 71.13 to phase out packages approved under Safety Series 6. This Option would include a 4-year transition period for the grandfathering provision on packages approved under Safety Series 6 (1967). This period will provide industry the opportunity to phase out old packages and phase in new ones. In addition, packages approved under Safety Series 6 (1985) would not be allowed to be fabricated after December 31, 2007. However, package designs approved under any pre-1996 IAEA standards (i.e., packages with a "-85" or earlier identification number) may be resubmitted to the NRC for review against current standards. If the package design described in the resubmitted application meets the current standards, the NRC may issue a new CoC for that package design with a "-96" designation. The affected attributes are described below:

- Industry Implementation – The change would result in implementation costs to industry but the magnitude of the costs depend upon the type of package and the required actions. For example, package designs that already meet current safety standards would have fewer costs than recertifying packages that cannot be shown to meet current safety standards. In general, the types of costs industry could bear include costs to develop new package design(s) and or package modification(s), costs to analyze and physically test these new package design(s) and or package modification(s), costs to develop revised package applications, and then costs to implement these new design(s) and or package modification(s) across the fleet of packages.

- NRC Implementation – The change would result in implementation costs to the NRC. The NRC would have to revise regulatory guides and NUREG-series documents in order to indicate which packages are covered by the "grandfathering of older packages" provision.

- Other Government – The change could affect implementation and operation costs of Agreement States if they adopt and implement parallel requirements. (The change is not expected to affect implementation or operation costs of DOT.) If Agreement States adopt the "grandfathering of older packages" provision, they would only need to revise documents that they have developed specifically for their licensees (e.g., application materials).

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

Several commenters responded to NRC's request for cost-benefit and exposure data and provided such data. The cost estimates shown below associated with development of designs, testing, preparation of application are extrapolated from information provided by commenters.

Estimated Costs to Industry

NRC staff believe that industry costs will depend upon which package design is being used but that these designs are likely to fall within one of five categories. The costs associated with each category are discussed below:

1. Package designs that meet current safety standards with no modifications, but have not been submitted for re-certification. This category includes package designs for which there is a sufficient supporting technical safety basis. For example, test data and engineering analyses exist and are still relevant to the current safety standards.

   Costs associated with these package designs include the following:

   - Development of an application ($10,000 - $50,000 for approximately 200 staff hours of work)
   - Review costs for NRC certification ($20,000 for 135 hours on a non-spent fuel amendment)

   Total costs may range from $30,000 to $70,000 per package design.

2. Package designs that can be shown to meet current safety standards with relatively minor design changes.

   Costs associated with these package designs include the following:

   - Design analysis and physical testing for modifications ($10,000 - $100,000)
   - Development of revised package application ($10,000 - $50,000 for approximately 200 staff hours of work)
   - Review costs for NRC certification ($20,000 for 135 staff hours for review of non-spent fuel amendment requests)
   - Packaging modifications to fleet of packagings (minor - $200 per packaging, major - $5K per packaging)

   The total cost would therefore be expected to be in the range of $40,000 to $170,000, depending on the deficiencies in the design or testing information. This does not include the costs for making the physical changes in the packagings, which could vary significantly for different package types and different design modifications, in addition to the number of packagings that needed to be modified.

3. Package designs that may meet current safety standards but are impractical to recertify.

This category is intended to capture the special nature of spent fuel casks that were certified to the 1967 IAEA standards. These package designs are considered as a separate category because: (1) domestic regulatory design standards for spent fuel casks existed before standards for other package types, (2) quality assurance requirements were universally applied to this type of package, whereas other package types were not subjected to the same level of quality assurance either for design or fabrication, and (3) these packages normally have a limited specific use, and are therefore not present in large numbers in general commerce.

For packages in this category, NRC staff will be willing to review an application, pursuant to § 71.8, that requests an exemption to specific performance requirements for which demonstration is not practical. The applicant would be free to propose, for example, additional operational controls that would provide equivalent safety. The exemption request could use risk information in justifying the continued use of these existing packagings.

Costs associated with these package designs include the following:

- Development of application, including risk information ($150,000)
- NRC review costs ($40,000 - based on 270 staff hours for a "non-standard" spent fuel package amendment request)

4. Package designs that cannot be shown to meet current safety standards.

Costs associated with these package designs include the following:

- Development of new designs ($100,000 -150,000)
- Analysis and physical tests ($50,000 to build a prototype plus $100,000 for testing and analysis)
- Development of package application ($10,000 - $50,000 for approximately 200 staff hours of work)
- NRC review costs ($40,000 - based on 270 staff hours for review of new designs for non-spent fuel amendment request)
- Fabrication costs ($50,000 per package)

The cost information for development of new designs and the analysis and testing of these newly designed packages (Category 4 above) was provided to NRC by industry commenters during the public comment period.

5. Packages for which the safety performance of the package design under the current safety standards is not known. This is due primarily to a lack of documentation available regarding the package design and performance.

For packages in Category 1 and 2 above, NRC staff judge that the expense of recertifying the design should be reasonable, and are small when considering the length of time these package designs have been in service (longer than 20 years). There is additional financial incentive for upgrading these designs, since upgrading would then allow additional packagings to be fabricated, and would allow certificate holders to request a wide range of modifications, both to the package design and the authorized contents.

NRC staff judge that it is appropriate to phase out the use of designs that fall into Categories 4 and 5 above. Staff believes that there are package designers that are willing and able to develop new designs provided a financial incentive. With the indefinite continued use of packages that cannot be shown to meet current standards, there will be no financial incentive to upgrade designs. In addition, most packagings certified to the 1967 design standards are more than 20 years old. Although proper maintenance of transportation packagings is required, it is not clear that the service life of many types of packagings would justify continued use for another revision cycle of the regulations.

The cost estimates associated with NRC review are based on historical information gathered over years of performing technical reviews of transportation package designs. There are many factors that significantly influence the review time associated with performing staff technical reviews for new package designs and amendments. Some of the most important factors are: quality of the application, design margins in the package, and a clear and unambiguous demonstration that the regulatory acceptance criteria have been met. The costs cited above are not considered maximum or minimum, but are representative and conservative averages, based on receipt of a complete and high-quality package application.

Estimated Costs to NRC

The NRC estimates that it would need to revise approximately 30 documents. On average, the time needed to make the necessary revisions is estimated to be 1.5 hours per document. Thus, the total burden for revising the documents is approximately 45 hours. At a rate of $77 per hour for professional staff, the cost for revising regulatory guides and NUREG-series documents to include the “grandfathering of older packages” provision is estimated to be $3,500.

Estimated Costs to Other Government

The number of documents that Agreement States would need to revise is estimated to be approximately 15. On average, the time needed to make the necessary revisions is estimated to be 0.5 hours per document. Thus, the total burden for revising the documents is approximately 7.5 hours. At a rate of $77 per hour for professional staff, the cost for revising Agreement State documents to include the “grandfathering of older packages” provision is estimated to be $578.

3.3.9 Changes to Various Definitions

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), NRC would not add or make changes to definitions in 10 CFR Part 71.4. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option 2

Under Option 2, NRC would add and change various definitions to 10 CFR 71.4 to ensure compatibility with definitions found in IAEA's TS-R-1. The affected attributes are expected to include:

- Industry Implementation – The change would result in implementation cost savings to industry. By modifying existing definitions and adding new definitions, licensees will benefit through more effective understanding of the requirements of Part 71.

- NRC Implementation – The change would result in implementation costs to the NRC. The NRC would have to revise regulatory guides and NUREG-series documents in order to include the new or revised definitions of 10 CFR 71.4.

- Other Government – The change could affect implementation and operation costs of Agreement States because they would have to adopt the revision to the various definitions in 10 CFR 71.4. (The change is not expected to affect implementation or operation costs of DOT.) It is assumed that Agreement States use regulatory guides and NUREG-series documents published by the NRC. Thus, Agreement States would only need to revise documents that they have developed specifically for their licensees (e.g., application materials).

- Regulatory Efficiency – The change is expected to improve regulatory efficiency by achieving consistency with international standards groups (e.g., IAEA).

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs to Industry

Industry will realize cost savings by benefitting from a more effective understanding of the requirements of Part 71. These cost savings are expected to be minimal, however, as they are not quantifiable due to the lack of available data.

Estimated Costs to NRC

It is estimated that approximately 30 documents would require revision. On average, the time needed to make the necessary revisions to the various definitions is estimated to be 1.5 hours per document. Thus, the total burden for revising the various definitions included in the 30 documents is approximately 45 hours. At a rate of $77 per hour for professional staff, the cost for revising the definitions in regulatory guides and NUREG-series documents is estimated to be $3,500.

Estimated Costs to Other Government

The number of documents that Agreement States would need to revise is estimated to be approximately 15. On average, the time needed to make the necessary revisions to the various definitions is estimated to be 0.5 hours per document. Thus, the total burden for revising the various definitions included in the 15 documents is approximately 7.5 hours. At a rate of $77 per hour for professional staff, the cost for revising the various definitions in Agreement State documents is estimated to be $578.

3.3.10 Crush Test for Fissile Material Package Design

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), the NRC would not modify Part 71 to incorporate the crush test requirement for fissile material packages. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option (2)

Under Option 2, the NRC staff would revise § 71.73©)(2) wording to agree with TS-R-1 and extend the crush test requirement to fissile material package designs. The affected attributes are described below:

- Regulatory Efficiency – The requirement would result in enhanced regulatory efficiency by correcting inconsistencies between Part 71 requirements and TS-R-1. However, further information on the impact of the TS-R-1 requirement for fissile material package testing is required.

- Industry Implementation – The change would result in implementation costs imposed to demonstrate compliance and may lead to the redesign of packages.

- NRC Implementation – The regulatory change would result in NRC implementation costs associated with modifying the regulations and revising guidance documents.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

Several commenters responded to NRC's request for cost-benefit and exposure data but no explicit cost data were provided. The commenters statements were focused on the following:

- NRC was told that the additional cost of the crush test for fissile materials is approximately $5 million which is to design, certify and manufacture replacement packages for shipment of uranium oxide. This will be required for three to five packages so they can pass the crush test. In addition, these changes will require recertification of the Certificates of Compliance.

Estimated Costs to Industry

To demonstrate compliance with the new regulations, industry may incur additional costs. In addition, industry may incur costs associated with package redesign. Because of the lack of available data, however, these costs were not previously estimated but one commenter suggested the costs associated with designing, certifying and manufacturing replacement packages for shipment of uranium oxide will be approximately $5 million.

Estimated Costs to NRC

NRC would be required to prepare documents and conduct other activities as a result of the action. It is estimated that these revisions would take approximately six staff-months to complete. Assuming a cost of $77 per hour for staff, and 20 staff days per month at 8 hours each, this results in a total cost of approximately $74,000. These costs have already been accounted for in this analysis.

3.3.11 Fissile Material Package Designs for Transport by Aircraft

<u>Values and Impacts of Option 1</u>

Under the No-Action Alternative (Option 1), the NRC would not modify Part 71 to incorporate the TS-R-1 requirements contained in paragraph 680. Thus, no values or impacts would result from Option 1.

<u>Values and Impacts of Option (2)</u>

Under Option 2, NRC would adopt TS-R-1, paragraph 680, Criticality evaluation, in a new § 71.55(f) that only applies to air transport. Section 71.55 specifies the general package requirements for fissile materials, and the existing paragraphs of § 71.55 are unchanged. Given that NRC has deferred adoption of the Type C packaging tests and TS-R-1, paragraph 680 applies to more than Type C packages, only the salient text would be inserted into § 71.55(f) and would only apply to domestic shipments. The affected attributes are described below:

- Industry Implementation – The regulatory change would result in implementation savings to industry because they would only need to perform an analysis of their packages if they planned to ship fissile material by air.

- NRC Implementation and Operation – The change would result in costs to NRC associated with revising guidance manuals and reviewing amendments. Neither of these types of costs are expected to be significant.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs to Industry

NRC expects that relatively few amendments will be submitted. It estimates that industry would prepare 10 analyses and that each amendment would cost less than $10,000 (approximately 100 to 125 hours to develop at $77 per hour). NRC staff review would cost another $11,600 (approximately 150 hours at $77) with the total costs for this change likely to be $21,600.

Estimated Costs to NRC

NRC would be required to prepare documents and conduct other activities as a result of the action. It is estimated that these revisions would take approximately six staff-months to complete. Assuming a cost of $77 per hour for staff, and 20 staff days per month at 8 hours each, this results in a total cost of approximately $74,000. These costs have already been accounted for in this analysis

3.4 Values and Impacts of NRC-Specific Changes

3.4.1 Special Package Authorizations

The December 1996 revision of the safe transport standards (TS-R-1) developed by the IAEA, provides specific procedures for demonstrating the level of safety for shipment of special packages.

<u>Values and Impacts of Option 1</u>

Under the No-Action Alternative (Option 1), NRC would continue to address approval of special packages using exemptions under 10 CFR 71.8. Thus, no values or impacts would result from Option 1.

<u>Values and Impacts of Option 2</u>

Under Option 2, NRC would incorporate new regulations into 10 CFR Part 71 that similarly address shipment of special packages and demonstrate an acceptable level of safety. The special package authorization would apply only in limited circumstances and only to one-time shipments of large components. Further, any such special package authorization would be issued on a case-by-case basis, and requires the applicant to demonstrate that the proposed shipment would not endanger life or property nor the common defense and security, following the basic process used by applicants to obtain Certificate of Compliance for nonspecial packages from NRC.

The applicant would be required to provide reasonable assurance that the special package, considering operational procedures and administrative controls employed during the shipment, would not encounter conditions beyond those for which it had been analyzed and demonstrated to provide protection. NRC would review each application and would consult with DOT on making the determinations required to issue an NRC special package authorization. Approval would be based on staff determination that the applicant met the requirements of Subpart D. If approved, the NRC would issue a CoC or other approval (i.e., special package authorization letter). The following attributes are expected to be affected:

- Public Health (Accident) – The action would provide added safeguards against radiation exposure to humans. Special package shipments are likely to increase regardless of the outcome of this rulemaking, as a result of future decommissioning activities. The justification for authorizing special packages for shipment is a decreased risk of radiation exposure to the public and workers as opposed to the shipment alternatives.

- Occupational Health (Accident) – See discussion for Public Health (Accident) above.

- Occupational Health (Routine) – See discussion for Public Health (Accident) above.

- Industry Implementation and Operation – Although licensees would realize savings by not having to prepare environmental assessments for special packages, they would still need to prepare a Safety Evaluation that demonstrate the level of safety being maintained. There is likely to be no change in costs or savings for industry.

- NRC Implementation and Operation – The action would result in savings to NRC by eliminating the need for the Commission to review each application.

- Regulatory Efficiency – The action would result in enhanced regulatory efficiency by standardizing the requirements to provide greater regulatory certainty and clarity than the no-action option, and would ensure consistent treatment among licensees requesting authorization for shipment of special packages. This increase in regulatory efficiency, however, would depend in part on modifications to DOT's regulations to recognize NRC special package exemptions.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs and Savings to Industry

The staff believe this change will not substantially alter the application and submissions by licensees. The reason being that they would still need to prepare a Safety Evaluation. Therefore, no costs or savings are estimated for this change.

Estimated Costs and Savings to NRC

The action would benefit NRC in that NRC would realize savings by streamlining the mechanism for reviewing special package applications. However, these special package applications are anticipated to be relatively few in number – i.e., one every few years. Due to limited data availability, the values of this change to the NRC have not been quantified in this analysis.

The change under Option 2 would result in other values that are not quantified in this analysis. In particular, the change would result in enhanced regulatory efficiency because it would provide greater regulatory certainty and clarity than the no-action option and would ensure consistent treatment among all licensees requesting authorization for shipment of special packages.

3.4.2 Expansion of Part 71 Quality Assurance Requirements to Certificate of Compliance (CoC) Holders

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), NRC would not subject CoC Holders or CoC applicants to the requirements contained in 10 CFR Part 71. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option 2

Under Option 2, NRC would explicitly subject CoC Holders and CoC applicants to the requirements contained in 10 CFR Part 71. NRC also would add recordkeeping and reporting requirements for CoC Holders and CoC applicants. The attributes expected to be affected by this action are described below:

- Public Health, Onsite and Offsite Property -- By incorporating CoCs and CoC applicants in Part 71, any deficiencies noted by NRC will result in a notice of violation (NOV). This enforcement action will allow NRC to issue orders or take other enforcement actions necessary to ensure compliance with Part 71 requirements. This will ultimately lead to safer transportation casks, although this benefit is small and impossible to quantify relative to the current safety levels of transportation casks.

- Industry Implementation and Operation – CoCs and CoC applicants will incur costs associated with understanding and implementing the new regulations. They also will have to submit reports under Part 71 that they were not submitting previously. These reports are described in SECY 99-174; it is assumed that similar reports will be required if CoCs and CoC applicants are incorporated in the Part 71 applicability. SECY 99-174 states that "Additional requirements for recordkeeping and reporting for certificate holders are needed, to include records required to be kept as a condition of the CoC [certificate of compliance]. This will provide an enforcement basis equivalence to the record keeping and reporting regulations for licensees."

- NRC Implementation and Operation – NRC will incur costs associated with supervising CoCs and CoC applicants, and maintaining and reviewing the records for submittals.

- Regulatory Efficiency – NRC's ability to issue NOVs to CoCs and CoC applicants will improve the regulatory efficiency of NRC enforcement actions. NRC can follow up the issuance of NOVs with more strict regulatory enforcement actions. This is not currently possible under Part 71, because CoCs and CoC applicants are not explicitly subject to the regulations of Part 71.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs to Industry

For the 31 CoC Holders, the burden associated with recordkeeping and reporting was determined to be 100 hours per year, from the Part 72 rulemaking. Assuming a cost of $77 per hour for staff, the estimated total cost to these entities is therefore approximately $239,000 per year.

Estimated Costs to NRC

NRC will incur costs associated with tracking submissions to the agency. It was assumed that NRC will spend approximately 20 hours per year per CoC Holder for these activities. Assuming a cost of $77 per hour, the total cost to the NRC is estimated at approximately $48,000.

3.4.3 Adoption of ASME Code

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), NRC would retain the current QA provisions for the package approval process so that the on-site presence of the ANI would not be required and NRC inspections of licensee and fabrication facilities would continue. Thus, no values or impacts would result from Option 1.

NRC notes that, if the ASME code is not implemented for spent fuel casks, the current inconsistent system of licensee QA procedures would remain in place. NRC and the licensees would be responsible for ensuring that adequate QA procedures are followed. NRC does not have the staffing capability to engage in full-time fabricator supervision. Licensees and contractors would therefore continue to self-certify that they are implementing a competent QA plan and continue their own QA procedures. The marginal improvement in cask safety obtained through implementation of the ASME code would therefore not be achieved.

Values and Impacts of Option 2

Under Option 2, NRC would adopt the ASME B&PV Code Section III, Division 3, for spent fuel transportation casks in 10 CFR Part 71. This action would eventually apply to spent fuel storage canister confinement and spent fuel transportation cask containment for all applications, including dual-purpose casks. The attributes expected to be affected by this action include:

- Public Health, Onsite and Offsite Property -- Transportation and dual-purpose casks manufactured under the ASME B&PV Code, Section III, Division 3 will be manufactured using QA/QC procedures that are more complete than those presently in place. The casks are, therefore, less likely to fail during a transportation accident and are less likely to contain a design flaw that would lead to a leak of radioactive material. For these reasons, the ASME-certified casks provide a lesser risk to public health and property. Although this is clearly a benefit of the proposed rule, the likelihood of a flawed cask being involved in an accident or leak is so remote that the public health/property benefits of the ASME QA/QC program relative to the current licensee/NRC program are impossible to quantify.

- Industry Implementation and Operation – CoC Holders and manufacturers will incur additional costs due to: (1) conducting a site survey of the production facility, (2) the review of cask design plans by a professional engineer, and (3) the employment of an on-site authorized nuclear inspector (ANI). CoC Holders and manufacturers will save costs associated with fabrication errors, such as having to repair faulty casks, and lost sales during faulty cask repair. They also will save the costs associated with employing an onsite QA/QC inspector. However, because of the potential for the ASME code to be revised over the next several years, adoption at this time could result in additional costs to licensees should the regulations be revised in the future.

- NRC Implementation and Operation – NRC will save some costs, by reducing the need for full-time inspectors who periodically inspect CoC Holders and fabricators. This on-site inspection function will be carried out by the authorized nuclear inspector (ANI). However, because of the potential for the ASME code to be revised over the next several years, adoption at this time could result in additional costs to NRC should the regulations need to be revised in the future.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs and Savings to Industry

Currently, there are six transportation cask fabricators.[22] On-site, one-time ASME survey costs will total approximately $440,000. Costs for ASME certification and the on-site authorized nuclear inspector (ANI) will total approximately $765,000 per year, although the fabricators will save approximately $450,000 per year because they will not have to employ an on-site QA/QC inspector (this function is filled by the ANI). Thus, the net yearly cost increase to the fabricators is $315,000.

In addition, industry will save costs associated with avoiding fabrication errors that will be discovered by the ANI. Although these savings are impossible to quantify on a per year basis, NRC documented one case in which a fabricator and NRC spent $570,000 inspecting and repairing flawed casks. The fabricator was estimated to have lost $2.1 million in sales during this time, because its resources were directed at affecting repairs to the flawed casks and not to cask production. It is assumed that an on-site ANI would have discovered the production flaw.

3.4.4 Change Authority for Dual-Purpose Package Certificate Holders

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), licensees or cask certificate holders would still be required to gain NRC approval for changes to procedures, or cask designs, through license amendments. Thus, no values or impacts would result from Option 1.

[22] Personal communication with Ron Parkhill, U.S. Nuclear Regulatory Commission, October, 1999.

Values and Impacts of Option 2

Under Option 2, NRC proposes to revise 10 CFR Part 71 to add a new section regulating dual-purpose spent fuel storage and transportation packages used for domestic transport only. In addition to providing a new process for approving dual purpose transportation packages, the new requirements currently proposed would provide the authority for CoC holders to make some changes to a dual-purpose package design without prior NRC approval. The proposed section also would include new requirements for submitting and updating a Final Safety Analysis Report (FSAR) describing the package's design. A discussion of the attributes expected to be affected by the action is provided below:

- Industry Implementation and Operation – CoC holders will have to expend resources associated with understanding and implementing the new requirements. Applicants will have to develop an accident analysis for their package as part of their application. CoC holder will incur costs in preparing and documenting all safety analyses and evaluations supporting changes made without prior NRC review and approval. Applicants will also incur costs when submitting an FSAR detailing minor changes, tests, and experiments they make to the design or procedures on a two-year basis. CoC holders will have an increase in NRC fees for the review of their applications due to the need to review the accident analysis and a review of methodologies used in the design basis. NRC fees related to inspections of documentation supporting the change authority will increase. The CoC holders will save costs associated with preparing amendments and paying fees to NRC that are required under the current regulations (i.e., because these will no longer be required if provisions similar to 10 CFR 72.48 are implemented in Part 71).

- NRC Implementation and Operation – The NRC will have to expend significant resources to develop regulatory guidance on accident analysis, the change process, fissile product barriers, and reviews of methodologies used in the design basis. NRC will realize cost savings associated with no longer having to review license amendments for CoC holders making minor changes to their design. These cost savings will be offset in that NRC will need to review updates to the FSAR that are required to be submitted by CoC holders making minor changes and the NRC will have to increase inspection resources to verify CoC holder compliance with the change authority provisions.

- Regulatory Efficiency – There would be a clearer and more consistent interpretation between the NRC and CoC holders regarding changes made under § 72.48 and Part 71.

Due to data limitations, only a portions of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs and Savings to Industry

For estimation purposes we have assumed that their will be 10 dual-purpose spent fuel storage cask and transportation package applications. The cost for developing an application is estimated to be $250,000. The NRC staff review of an application is assumed to be $250,000 per review. For the 10 dual-purpose spent fuel storage cask and transportation packages, professional judgment was used to assume that in any given year 50 percent of licensees will perform a “minimal change.” Updated FSAR’s are to be submitted every two years and therefore, about 10 total submittals are expected per year. However, due to the relatively small resource expenditures on amendments for minor changes, it is assumed that the costs the CoC holder will incur in preparing and documenting all safety analyses and evaluations supporting changes made without prior NRC review and approval and the two-year FSAR submittal will offset the cost savings of not preparing five amendments per year.

If this section is implemented, the one time cost to prepare an FSAR and NRC fees to review applications are estimated to be $5,000,000.

Estimated Cost Savings to NRC

NRC costs are projected to increase with Option 2. NRC staff guidance development for implementation of Subpart I of the rule is estimated to be $1,000,000. It is estimated that casework would decline slightly under this option, because the agency will not have to review as many license amendments each year. This cost savings will be offset by the agency having to adopt new document controls to handle the updated FSAR submissions required every two years for licensees making changes to the design or procedures under the provisions of Subpart I and inspection related costs to verify compliance with the change authority.

3.4.5 Fissile Material Exemptions and General License Provisions

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), NRC would not modify 10 CFR Part 71 to implement the 17 recommendations contained in NUREG/CR-5342, but would continue to use the modified regulations promulgated under 10 CFR Part 71, RIN 3150-AF58, Fissile Material Shipments and Exemptions, final rule. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option 2

Under Option 2, NRC would modify the 10 CFR Part 71 regulations to implement 16 of the 17 recommendations contained in NUREG/CR-5342. (Recommendation 6 would not be adopted.) The net effect of adopting these 16 recommendations would be to make the following changes:

- Add language in § 71.14 for an exemption from the other requirements of Part 71 for materials that meet the fissile exemptions in § 71.15.

- Revise § 71.15 to include controls on fissile package mass limit combined with package fissile-to-nonfissile mass ratio.

- Add an exemption in § 71.15 for individual packages containing two grams or less fissile material.

- Create new § 71.22 by consolidating and simplifying current fissile general license provisions from existing §§ 71.18, 71.20, 71.22, and 71.24, revise the mass limits and add Type A, CSI, and QA requirements. The general license would now rely on mass-based limits and the CSI.

- Create new § 71.23 by consolidating the existing general license requirements for plutonium-beryllium sealed sources, which are contained in existing §§ 71.18 and 71.22 into one general license and revise the mass limits.

The attributes expected to be affected by these actions include:

- Public Health (Accident) – Changes to radiation exposures to the public, due to changes in accident frequencies and accident consequences, could result from the action. The regulatory options could both alter the number of fissile shipments (thereby altering the accident frequency) and reduce the likelihood of occurrences of criticality (thereby reducing accidental consequences).

- Occupational Health (Accident) – Changes to radiation exposures to workers, due to changes in accident frequencies and accident consequences, could result from the action. The regulatory options could both alter the number of fissile shipments (thereby altering the accident frequency) and reduce the likelihood of occurrences of criticality (thereby reducing accidental consequences).

- Occupational Health (Routine) – Changes to radiation exposures to workers during normal packaging and transportation operations could result from the action. The regulatory options could alter the number of fissile packages or shipments, thereby altering the number of workers exposed or the duration of the exposure.

- Offsite Property – Effects on offsite property, due to changes in accident frequencies and accident consequences, could result from the action. The regulatory options could both alter the number of fissile shipments (thereby altering the accident frequency) and reduce the likelihood of occurrences of criticality (thereby reducing accidental consequences).

- Onsite Property – Effects on onsite property (direct and indirect), due to changes in accident frequencies and accident consequences, could result from the action. The regulatory options could both alter the number of fissile shipments (thereby altering the accident frequency) and reduce the likelihood of occurrences of criticality (thereby reducing accidental consequences).

- Industry Implementation – The action would result in implementation costs or savings to industry if industry must evaluate and/or enact changes to ensure that its operating procedures will comply with the action.

- Industry Operation – The action would result in industry operation costs or savings if industry must alter its current packaging and shipping procedures to comply with the action.

- NRC Implementation – The action would result in NRC implementation costs or savings to put the action into operation. Specifically, NRC would incur implementation costs to revise guidance documents.

- NRC Operation – The action would result in NRC operation costs or savings if the number of shipments requiring specific NRC approval changes (i.e., the number of shipments that fail to qualify for the fissile exemption and the general licenses).

- Regulatory Efficiency – The action would be expected to result in enhanced regulatory efficiency by clarifying the meaning and applicability of specific terms and requirements, and by reducing noncompliance.

- Environmental Considerations – Effects on the environment, due to changes in accident frequencies and accident consequences, could result from the action. The regulatory options could both alter the number of fissile shipments (thereby altering the accident frequency) and reduce the likelihood of occurrences of criticality (thereby reducing accidental consequences).

- Other Government – The action could affect implementation and operation costs of the U.S. Department of Energy, to the extent that its fissile material shipments must comply with NRC regulations. The action also could affect implementation and operation costs of Agreement States if they must enact and implement parallel requirements. (The action would not be expected to affect implementation or operation costs of DOT.)

NRC sought detailed information from industry to assist in developing a quantitative estimate of the values and impacts associated with the changes to the fissile material packaging and transportation requirements. In order to develop these estimates, significant data needs existed, including the following:

- Number/types of packages/shipments containing the radionuclide ^{238}Pu.

- Number of packages/shipments of fissile material having a specific activity greater than 43 Bq/g but less than 70 Bq/g.

- Number/type of packages/shipments containing Pu-Be sources, including the quantity of plutonium.

- Number of packages/shipments falling under each of §§ 71.18, 71.20, 71.22, and 71.24, and the TI and/or aggregate TI further distinguished by exclusive use versus non-exclusive use.

- Number/types of packages/shipments per conveyance.

- Number/type of packages/shipments currently falling under §§ 71.20 and 71.24 that contain ^{235}U broken out by (1) the number of grams for each ^{235}U enrichment weight percentage, and (2) whether the fissile radionuclides are distributed uniformly and cannot form a lattice arrangement within the packaging.

- Number/types of packages/shipments currently shipped under §§ 71.18(e) and 71.22(e) containing Be, C, and D_2O, and how much Be, C, and D_2O is contained (in grams and as a percent of fissile material mass).

- Number/types of packages/shipments of fissile materials with high-density hydrogenous moderators exceeding 15% of the mass of hydrogenous moderator in the package.

- Number/types of packages/shipments of fissile materials broken out by the ratio of the mass of fissile material per mass of nonfissile material that is non-combustible, insoluble in water, and not Be, C, or D_2O.

- Number/type of packages/shipments that both currently fall under § 71.53 and contain Be, C, and D_2O.

- Number/type of package/shipments broken out by TI.

- Number/type of package/shipments that currently fall under the § 71.53©) exemption for uranyl nitrite solutions transport.

- Number/type of additional packages/shipments that would fall under § 71.53(b) absent the requirement that the fissile material were distributed homogeneously throughout the package contents and that the material not form a lattice arrangement within the package.

- To the extent not determinable based on the above information, the number/types of such packages meeting § 71.53, and currently shipped under §§ 71.18, 71.20, 71.22, 71.24, and/or under Subparts E and F.

Such data are not readily available, and much of the data may not exist at all.[23] Consequently, this study analyzes values and impacts on a qualitative basis taking into account the regulatory option, each individual affected attribute, other factors influencing these attributes (e.g., potential for criticality, potential for radiation exposure, number of required packages and/or shipments, efforts required to make regulatory determinations or calculations, recordkeeping and reporting requirements), and applicable discussion and analysis contained in NUREG/CR-5342. Values and impacts reported for several attributes are based on analysis presented in a related environmental assessment prepared for this rulemaking.

Each of the 16 recommendations would result in certain values and/or impacts. Thus, the values and impacts of Option 2 as a whole consist of the sum of all values and impacts associated with these 16 recommendations.

Table 3-3 summarizes the values and impacts associated with each of the 16 adopted recommendations from NUREG/CR-5342.

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[23] Survey data on radioactive material shipments are not specific enough for use in the present analysis and, moreover, are almost two decades old ("Transport of Radioactive Material in the United States," SRI International, April 1985).

Table 3-3. Values and Impacts Associated with Actions Related to NUREG/CR-5342 Recommendations

ATTRIBUTE	ACTION																
	1	2	3	4	5	6*	7	8	9	10	11	12	13	14	15	16	17
Public Health (Accident)		V(X)	V©)	?			V©) I(X)	V©)	?(X)	V©) ?(X)	?(X)	V(X)	V©) I(X)	V©) ?(X)	V(C)?(X)	V(C,X)	
Occupational Health (Accident)		V(X)	V©)	?			V©) I(X)	V©)	?(X)	V©) ?(X)	?(X)	V(X)	V©) I(X)	V©) ?(X)	V(C)?(X)	V(C,X)	
Occupational Health (Routine)		V(X)		?			I(X)		I(X)	?(X)	V(X)	?(X)	V(X)	?(X)	?(X)		
Offsite Property		V(X)	V©)	?			V©) I(X)	V©)	?(X)	V©) ?(X)	?(X)	V(X)	V©) ?(X)	V©) ?(X)	V(C)?(X)	V(C,X)	
Onsite Property		V(X)	V©)	?			V©) I(X)	V©)	?(X)	V©) ?(X)	?(X)	V(X)	V©) ?(X)	V©) ?(X)	V(C)?(X)	V(C,X)	
Industry Implementation		V(S,G)	I(S)	I(S,G)			I(S,G)	I(G)	V(G) ?(S)	V(G) ?(S)	V(G)	I(S)	V(S)	V(G) ?(S)	V(G) ?(S)	I(S)	V(G)
Industry Operation		V(S,G)	I(S)	I(S,G)			I(S,G)	I(G)	?(S)	V(G) ?(S)	V(S,G)	I(S)	V(S)	V(G) ?(S)	V(G)?(S)	I(S)	V(G)
NRC Implementation	I	I	I	I	I		I	I	I	I	I	I	I	I	I	I	I
NRC Operation		V(G)	?							?	V(G)			?	?		V(G)
Regulatory Efficiency	V	V			V		V	V		V	V	V	V	V	V	V	V
Environmental Considerations		V(X)	V©)	?			V©) I(X)	V©)	?(X)	V©) ?(X)	?(X)	V(X)	V©) ?(X)	V©) ?(X)	V(C)?(X)	V(C,X)	
Other Government		V(S,G)	I(S)	I(S,G)			I(S,D)	I(G)	V(G) I(S)	V(G) ?(S)	V(S,G)	I(S)	V(S)	V(G) ?(S)	V(G) ?(S)	I(S)	V(G)
Improvements in Knowledge																	

*** Recommended Action 6 was not adopted by NRC.**
KEY: Values/Impacts: V = Value; I = Impact; ? = Direction of effect is uncertain due to data limitations
Factors influencing attributes: C = Criticality potential; X = Radiological exposure; S = number (or cost) of packages and/or shipments; G = Regulatory determinations/ calculations; R = Recordkeeping/reporting

- Recommendation 1 – The action would result in enhanced regulatory efficiency due to increases in the clarity of NRC's regulations and improvements in the consistency between 10 CFR Part 71, 49 CFR Part 173, and IAEA No. TS-R-1. It also is conceivable that the action could result in a reduced potential for criticality due to the increased understanding of the regulations that would likely result.

- Recommendation 2 – The action would result in enhanced regulatory efficiency due to increases in the clarity of NRC's regulations and improvements in the consistency between 10 CFR Part 71 and IAEA No. TS-R-1. Also, licensees potentially could incur lower costs primarily due to reduced fissile shipments. As a result of the reduction in total fissile shipments, the potential for radiological exposures also would be reduced, yielding environmental, health, safety, and avoided offsite and onsite property damage benefits.

- Recommendation 3 – The action would increase costs to licensees, but would reduce the potential for criticality and thus would yield environmental, health, safety, and avoided offsite and onsite property damage benefits.

- Recommendation 4 – The action would most likely increase the regulatory burden on licensees and could result in increased costs to licensees due to necessary increases in the number of fissile material shipments. An increase in total fissile shipments would, in turn, increase the potential for radiological exposures, yielding possible negative impacts on the environment, health, safety, and offsite and onsite property. The net effect is uncertain, however, because of the potential for reductions in criticality.

- Recommendation 5 – The action would result in enhanced regulatory efficiency by consolidating the sections of 10 CFR Part 71 that pertain to exemptions into a single subpart.

- Recommendation 6 – Not adopted.

- Recommendation 7 – The action would eliminate the potential for criticality and thus would yield environmental, health, safety, and avoided offsite and onsite property damage benefits. The action also would impose costs on licensees through added packaging requirements, increased shipments, and increased regulatory burden. The increase in shipments could, in turn, increase the potential for radiological exposures during shipping. However, the reduction in criticality risk would largely outweigh the risks from these exposures. The recommendation also would result in enhanced regulatory efficiency by creating a separate general license for Pu-Be sources, thus increasing the clarity of NRC's regulations.

- Recommendation 8 – The action would eliminate the potential for criticality and thus would yield environmental, health, safety, and avoided offsite and onsite property damage benefits. The action would impose an increased regulatory burden on licensees, however, in that it would require licensees to perform additional calculations related to the aggregate transport index. This recommendation also would result in enhanced regulatory efficiency by consolidating certain sections of 10 CFR Part 71 and by increasing the clarity of NRC's regulations.

- Recommendation 9 – The action would affect licensees' costs and may have, potentially, minor effects on radiological exposures. The action also would reduce the regulatory burden on licensees by reducing their administrative implementation costs (i.e., it would reduce the number of calculations licensees would need to make in determining permissible masses).

- Recommendation 10 – The action would eliminate the potential for criticality and thus would yield environmental, health, safety, and avoided offsite and onsite property damage benefits. Also, by modifying the Be, C, and D_2O quantity restrictions to incorporate a mass-based limit rather than a percentage-based limit, the action would reduce the number of calculations licensees would need to make in order to determine compliance with the regulations, thus reducing regulatory burden. The action also would result in enhanced regulatory efficiency by simplifying and clarifying NRC's regulations.

- Recommendation 11 – The action would reduce regulatory burden on licensees by simplifying the calculation of fissile material quantities and the categorization of mass limits. The action also would result in enhanced regulatory efficiency by simplifying and clarifying NRC's regulations.

- Recommendation 12 – The action would result in licensees incurring higher costs in meeting the added packaging requirements for shipments under the general licenses. As a result of these requirements, however, the potential for radiological exposures would be reduced, yielding environmental, health, safety, and avoided offsite and onsite property damage benefits. (The potential for criticality would not be affected by this recommendation.) The action also would result in enhanced regulatory efficiency due to increases in consistency within NRC's regulations.

- Recommendation 13 – The action would eliminate the potential for criticality and thus would yield environmental, health, safety, and avoided offsite and onsite property damage benefits. Also, the action would reduce regulatory burden on licenses by simplifying the calculation of fissile material quantities and the categorization of mass limits. The action also would result in enhanced regulatory efficiency due to increases in consistency within NRC's regulations.

- Recommendation 14 – The action would eliminate the potential for criticality and thus would yield environmental, health, safety, and avoided offsite and onsite property damage benefits. Also, the action would reduce regulatory burden on licenses by simplifying certain calculations that would need to be made in order to comply with the regulations. The action also would result in enhanced regulatory efficiency due to increases in consistency within NRC's regulations.

- Recommendation 15 – The action would eliminate the potential for criticality and thus would yield environmental, health, safety, and avoided offsite and onsite property damage benefits. Also, the action would reduce regulatory burden on licenses by simplifying certain calculations that would need to be made in order to comply with the regulations. The action also would result in enhanced regulatory efficiency due to increases in consistency within NRC's regulations.

- Recommendation 16 – The action would eliminate the potential for criticality and thus would yield environmental, health, safety, and avoided offsite and onsite property damage benefits. However, some licensees would incur higher costs under this action in meeting the added packaging requirements for transport of uranyl nitrite solutions. The action also would result in enhanced regulatory efficiency by simplifying NRC's regulations.

- Recommendation 17 – The action would result in savings to licensees with respect to determining whether package contents are homogeneous and form a lattice arrangement within the package. The action also would result in enhanced regulatory efficiency by simplifying NRC's regulations.

Given the severe data limitations, this analysis provides only minimal quantitative analysis of values and impacts associated with the changes to the fissile material requirements.

No cost data were received from either the public or industry.

Estimated Costs to Industry

Industry may incur costs due to changes in fissile material exemptions. These costs are not quantifiable, however, due to a lack of available data.

Estimated Costs to NRC

NRC may also incur costs due to changes in fissile material exemptions. These costs are not quantifiable, however, due to a lack of available data.

3.4.6 Double Containment of Plutonium (PRM-71-12)

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), NRC would retain the § 71.63 special requirements for plutonium shipments, which would place increased plutonium shipping requirements in the U.S. compared to the IAEA requirements. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option 2

Under Option 2, NRC would delete § 71.63(b) and its special requirements for plutonium shipments. Plutonium packaging requirements would be handled no differently than requirements for other nuclear material (i.e., the A_1/A_2 system to determine if a Type B package is required) except for those shipments whose contents contain greater than 0.74 TBq (20 Ci) of plutonium. Such shipments would be required to be made with the contents in solid form.

The attributes expected to be affected are described below:

- Public Health (Accident) – Removing a layer of packaging (protection) increases the probability and consequences of accidents that can breach the Type B package. It is anticipated, therefore, that an increase in exposure could result during an accident. The additional costs that might be incurred as a result will be developed with the preparation of the Environmental Assessment supporting this proposed rulemaking.

- Occupational Health (Routine) – Workers receive additional exposure while sealing the second layer of packaging. Eliminating this step and the associated radiation exposure results in a reduction in possible exposure. The cost savings that might be incurred as a result will be developed with the preparation of the Environmental Assessment supporting this proposed rulemaking.

- Offsite Property – The consequences to offsite property increase in proportion to the increase radiological accident consequences. The costs/savings that might be incurred as a result will be developed with the preparation of the Environmental Assessment supporting this proposed rulemaking.

- Industry Implementation – Removing the requirement for double containment could reduce packaging costs.

- Industry Operation – Essentially all anticipated plutonium shipments would be done by DOE. (See Other Government.)

- NRC Implementation – Under the options, no additional costs to NRC are anticipated.

- Other Government – Removing the requirement for double containment could reduce operational costs.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

Several commenters responded to NRC's request for cost-benefit and exposure data but no explicit cost data were provided. The commenters statements were focused on the following:

- Continuing double containment from 2001 through 2010 would cost DOE more than an estimated $60 million for transuranic waste and plutonium oxide shipments.

- Not removing 10 CFR 71.63 could have significant cost impacts from design, certification, and fabrication of future packaging, such as the TRUPACT III or the DPP-1 and DPP-2.

Estimated Costs and Savings to Industry

Removing the requirement for double containment could reduce packaging costs. Packages being used for plutonium shipments and packages that are planned for plutonium shipments in the next decade meet the double containment requirement. These costs are not quantifiable, however, due to a lack of verifiable information on the costs for double containment package design and development.

Estimated Costs to NRC

Costs to NRC are not anticipated to change as a result of this revision – e.g., no new guidance documents are required.

3.4.7 Contamination Limits as Applied to Spent Fuel and High Level Waste (HLW) Packages

No regulatory changes are being proposed. Therefore, no regulatory options have been identified. As a result, no analysis was conducted.

3.4.8 Modifications of Event Reporting Requirements

Values and Impacts of Option 1

Under the No-Action Alternative (Option 1), NRC would not modify § 71.95 and would continue to require that a licensee submit a written report to the NRC within 30 days of three events: (1) a significant decrease in the effectiveness of a packaging while in use to transport radioactive material, (2) details of any defects with safety significance found after first use of the cask, and (3) failure to comply with conditions of the certificate of compliance (CoC) during use. Thus, no values or impacts would result from Option 1.

Values and Impacts of Option (2)

Under Option 2, NRC would revise § 71.95 to require that the licensee and certificate holder jointly submit a written report for the criteria in new subparagraphs (a)(1) and (a)(2). The NRC also would add new paragraphs ©) and (d) to § 71.95 which would provide guidance on the content of these written reports. This new requirement is consistent with the written report requirements for Part 50 and 72 licensees (i.e., §§ 50.73 and 72.75) and the direction from the Commission in SECY-99-181 to consider conforming event notification requirements to the recent changes made to Part 50. The NRC also would update the submission location for the written reports from the Director, Office of Nuclear Material Safety and Safeguards to the NRC Document Control Desk. Additionally, the NRC would remove the specific location for submission of written reports from § 71.95©) and instead require that reports be submitted "in accordance with section 71.1." Lastly, the NRC would reduce the regulatory burden for licensees by lengthening the report submission period from 30 to 60 days. The affected attributes are described below:

- Regulatory Efficiency – The change would result in enhanced conformity among Parts 50, 71, and 72.

- NRC Implementation – The change would result in NRC implementation costs for licensees for revising procedures and for training. A key benefit of the proposed amendments would be a reduction in the recurring annual reporting burden on licensees, as a result of reducing the efforts associated with reporting events of little or no risk or safety significance. It is anticipated that the NRC's recurring annual review efforts for telephone notifications and written reports will not be significantly reduced.

Due to data limitations, only a portion of the values and impacts described above can be quantified. The results that can be quantified based on available data are described below.

No cost data were received from either the public or industry.

Estimated Costs to Industry

It is estimated that the costs to industry for implementing this change are negligible, and thus, they have not been quantified.

Estimated Costs to NRC

NRC would be required to prepare documents and conduct other activities as a result of the action. It is estimated that these revisions would take approximately six staff-months to complete. Assuming a cost of $77 per hour for staff, and 20 staff days per month at 8 hours each, this results in a total cost of approximately $74,000.

4. Backfit Analysis

The regulatory options examined in this regulatory analysis do not involve any provisions that would require backfits as defined in 10 CFR Part 50.109(a)(1). Consequently, a backfit analysis is not necessary.

5. Decision Rationale

As discussed earlier in this analysis, NRC's regulatory action consists of 19 individual changes that (1) harmonize the radioactive transportation regulations in 10 CFR Part 71 with the IAEA's TS-R-1, and (2) simplify NRC's regulations, while maintaining the safety standards for containers used to ship and store radioactive waste, and reduce paperwork and burden for licensees seeking to make minor changes in their operations. For each of the 19 issues addressed by the final rule, the values and impacts associated with modifying its transportation regulations in 10 CFR Part 71 (as proposed under Option 2) and with adopting the No-Action alternative (Option 1) have been considered.

Due to severe data limitations on radioactive material shipments and other factors related to the rulemaking, ICF was unable to quantify a number of the values and impacts that are expected to occur as a result of Option 2. Even after NRC explicitly requested the public and industry help NRC improve the analyses supporting the rulemaking by providing cost-benefit and exposure data.

Nevertheless, given that the amendments described in Option 2 for each issue simplify the Part 71 requirements applicable to licensees shipping radioactive materials, increase consistency with other regulatory programs, relax certain restrictions on radioactive material packages and shipments that are not justified based on plausible criticality concerns, and ensure adequate criticality safety for a number of newly-considered plausible transportation and packaging situations, these options are generally preferable to Option 1. For some issues, however, it was determined that revising the regulations would not result in any net economic or safety-related benefits to licensees, NRC, other government agencies (e.g., DOE, DOT), or the public.

For each of the 19 changes, Table 5-1 below summarizes the options determined to be most preferable based on professional judgment and limited quantitative analysis.

Table 5-1. Summary of Preferred Options

Technical Issue	Preferred Option
1. Changing Part 71 to the International System of Units (SI) Only	Option 1 (No-Action)
2. Radionuclide Exemption Values	Option 2
3. Revision of A_1 and A_2	Option 2
4. Uranium Hexafluoride Package Requirements	Option 2
5. Introduction of the Criticality Safety Index Requirements	Option 2
6. Type C Packages and Low Dispersible Material	Option 1 (No-Action)
7. Deep Immersion Test	Option 2
8. Grandfathering Previously Approved Packages	Option 2
9. Changes to Various Definitions	Option 2
10. Crush Test for Fissile Material Package Design	Option 2
11. Fissile Material Package Designs for Transport by Aircraft	Option 2
12. Special Package Authorizations	Option 2
13. Expansion of Part 71 Quality Assurance Requirements to Certificate of Compliance (CoC) Holders	Option 2
14. Adoption of ASME Code	Option 1 (No-Action)
15. Change Authority	Undetermined
16. Fissile Material Exemptions and General License Provisions	Option 2
17. Double Containment of Plutonium (PRM-71-12)	Option 2
18. Contamination Limits as Applied to Spent Fuel and High Level Waste (HLW) Packages	For information only. No options identified.
19. Modifications of Event Reporting Requirements	Option 2

6. Implementation

Implementation will begin immediately following the enactment of the final rule. No impediments to implementation of the recommended alternatives have been identified. Regulatory Guides for licensees would be required to provide an explanation of the regulatory requirements and methods for complying with the revised packaging and transport requirements for fissile material shipments.

7. References

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U.S. Nuclear Regulatory Commission, “Assessment and Recommendations for Fissile-Material Packaging Exemptions and General Licenses Within 10 CFR Part 71,” NUREG/CR-5342, Oak Ridge National Laboratory, July 1998.

U.S. Nuclear Regulatory Commission, “Regulatory Analysis of Changes to 10 CFR Part 71 – NRC Regulations on Packaging and Transportation of Radioactive Material,” Division of Safeguards & Transportation, Office of Nuclear Material Safety & Safeguards, Washington, DC, August 1994.

U.S. Nuclear Regulatory Commission, “The Transportation of Radioactive Material by Air and Other Modes,” NUREG-0170, December 1977.

8. Glossary

A_1 means the maximum activity of special form radioactive material permitted in a Type A package. These values are listed in Appendix A - Table A-1 of 10 CFR Part 71 and may be derived in accordance with the procedure prescribed in Appendix A.

A_2 means the maximum activity of radioactive material, other than special form, LSA and SCO material, permitted in a Type A package. These values are listed in Appendix A - Table A-1 of 10 CFR Part 71 and may be derived in accordance with the procedure prescribed in Appendix A.

Becquerel means the special unit of activity in the SI system, equal to 1 disintegration per second.

Certificate holder means a person who has been issued a certificate of compliance or other package approval by NRC.

Committed dose equivalent means the total dose equivalent (averaged over a given tissue) deposited over the 50-year period following the intake of a radionuclide.

Committed effective dose equivalent means the weighted sum of committed dose equivalents to specific organs and tissues, in analogy to the effective dose equivalent.

Consignee means any person, organization, or government which receives a consignment.

Consignment means any package or packages, or load of radioactive material, presented by a consignor for transport.

Consignor means any person, organization, or government which prepares a consignment for transport, and is named as consignor in the transport documents.

Conveyance means any vehicle for transport by road or rail, any vessel for transport by water, and any aircraft for transport by air.

Criticality Safety Index means a number which is used to provide control over the accumulation of packages, overpacks, or freight containers containing fissile material.

Curie means the unit of radioactivity, equal to the amount of a radioactive isotope that decays at the rate of 3.7×10^{10} disintegrations per second.

Dose equivalent means the product of the absorbed radiation dose, the quality factor for the particular kind of radioactivity absorbed, and any other modifying factors. The SI unit of dose equivalent is the sievert (Sv) and the English or conventional unit is the rem.

Effective dose equivalent means the sum over specified tissues of the products of the dose equivalent in a tissue or organ and the weighting factor for that tissue or organ.

Exclusive use means sole use by a single consignor of a conveyance for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee. The consignor and the carrier must ensure that any loading or unloading is performed by personnel having radiological training and resources appropriate for safe handling of the consignment. The consignor must 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.

Exempt packages means packages exempt from the requirements of 10 CFR Part 71.

Fissile material means plutonium-238, plutonium-239, plutonium-241, uranium-233, uranium-235, or any combination of these radionuclides. Unirradiated natural uranium and depleted uranium, and natural uranium or depleted uranium that has been irradiated in thermal reactors only are not included in this definition. Certain exclusions from fissile material controls are provided in 10 CFR Part 71.53.

Licensed material means by-product, source, or special nuclear material received, possessed, used, or transferred under a general or specific license issued by NRC pursuant to 10 CFR Part 71.

Low dispersible radioactive material means either a solid radioactive material or a solid radioactive material in a sealed capsule, that has limited dispersibility and is not in powder form.

Low Specific Activity (LSA) material means radioactive material with limited specific activity that satisfies the descriptions and limits set forth in 10 CFR Part 71.4. Shielding materials surrounding the LSA material may not be considered in determining the estimated average specific activity of the package contents.

Non-special form (or normal form) radioactive material means radioactive material that has not been demonstrated to qualify as “special form radioactive material,” as defined below.

Q system is a series of models to consider radiation exposure routes to persons in the vicinity of a package involved in a hypothetical severe transport accident. The five models are for external photon does, external beta dose, inhalation dose, skin and ingestion dose due to contamination transfer, and submersion in gaseous isotopes dose.

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

Radionuclide means the type of atom specified by its atomic number, atomic mass, and energy state that exhibits radioactivity.

Special arrangement means those provisions, approved by the competent authority, under which consignments which do not satisfy all the applicable requirements may be transported.

Special form radioactive material means either an indispersible solid radioactive material or a sealed capsule containing radioactive material.

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 radioactive material distributed on its surfaces.

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 TI is determined as specified in 10 CFR Part 71.4.

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 49 CFR 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.

Type B package means a Type B packaging together with its radioactive contents. A Type B package design is designated by NRC as B(U) unless the package has a maximum normal operating pressure of more than 700 kPa (100 lb/in2) gauge or a pressure relief device that would allow the release of radioactive material to the environment under tests specified in 10 CFR Part 71.73, in which case it will receive a designation B(M). B(U) refers to the need for unilateral approval of international shipments. B(M) refers to the need for multilateral approval of international shipments. To determine this distinction see DOT regulations in 49 CFR Part 173.

Type C package means a new package type described in IAEA's ST-1 that could withstand severe accident conditions in air transport without loss of containment or increase in external radiation.

APPENDIX A

APPENDIX A
A_1 and A_2 Values for Radionuclides, and Exempt Material Activity Concentrations and Consignment Activity Limits for Radionuclides

Appendix A contains two tables that list the A_1 and A_2 values and exempt material values, both of which will appear in the revised Appendix A to 10 CFR Part 71. Table A-1 is a complete listing of the A_1 and A_2 values for radionuclides. Table A-2 is a complete listing of exempt material activity concentrations and consignment activity limits for radionuclides.

Table A-1. A_1 and A_2 Values for Radionuclides

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Ac-225 (a)	Actinium (89)	$8.0X10^{-1}$	$2.2X10^{1}$	$6.0X10^{-3}$	$1.6X10^{-1}$	$2.1X10^{3}$	$5.8X10^{4}$
Ac-227 (a)		$9.0X10^{-1}$	$2.4X10^{1}$	$9.0X10^{-5}$	$2.4X10^{-3}$	2.7	$7.2X10^{1}$
Ac-228		$6.0X10^{-1}$	$1.6X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$8.4X10^{4}$	$2.2X10^{6}$
Ag-105	Silver (47)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$1.1X10^{3}$	$3.0X10^{4}$
Ag-108m (a)		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$9.7X10^{-1}$	$2.6X10^{1}$
Ag-110m (a)		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.8X10^{2}$	$4.7X10^{3}$
Ag-111		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$5.8X10^{3}$	$1.6X10^{5}$
Al-26	Aluminum (13)	$1.0X10^{-1}$	2.7	$1.0X10^{-1}$	2.7	$7.0X10^{-4}$	$1.9X10^{-2}$
Am-241	Americium (95)	$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$1.3X10^{-1}$	3.4
Am-242m (a)		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$3.6X10^{-1}$	$1.0X10^{1}$
Am-243 (a)		5.0	$1.4X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$7.4X10^{-3}$	$2.0X10^{-1}$
Ar-37	Argon (18)	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$3.7X10^{3}$	$9.9X10^{4}$
Ar-39		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{1}$	$5.4X10^{2}$	1.3	$3.4X10^{1}$
Ar-41		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.5X10^{6}$	$4.2X10^{7}$
As-72	Arsenic (33)	$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$6.2X10^{4}$	$1.7X10^{6}$
As-73		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$8.2X10^{2}$	$2.2X10^{4}$
As-74		1.0	$2.7X10^{1}$	$9.0X10^{-1}$	$2.4X10^{1}$	$3.7X10^{3}$	$9.9X10^{4}$
As-76		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$5.8X10^{4}$	$1.6X10^{6}$
As-77		$2.0X10^{1}$	$5.4X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$3.9X10^{4}$	$1.0X10^{6}$
At-211 (a)	Astatine (85)	$2.0X10^{1}$	$5.4X10^{2}$	$5.0X10^{-1}$	$1.4X10^{1}$	$7.6X10^{4}$	$2.1X10^{6}$
Au-193	Gold (79)	7.0	$1.9X10^{2}$	2.0	$5.4X10^{1}$	$3.4X10^{4}$	$9.2X10^{5}$
Au-194		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.5X10^{4}$	$4.1X10^{5}$
Au-195	Gold (79)	$1.0X10^{1}$	$2.7X10^{2}$	6.0	$1.6X10^{2}$	$1.4X10^{2}$	$3.7X10^{3}$
Au-198		1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$9.0X10^{3}$	$2.4X10^{5}$
Au-199		$1.0X10^{1}$	$2.7X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$7.7X10^{3}$	$2.1X10^{5}$
Ba-131 (a)	Barium (56)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$3.1X10^{3}$	$8.4X10^{4}$
Ba-133		3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	9.4	$2.6X10^{2}$
Ba-133m		$2.0X10^{1}$	$5.4X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.2X10^{4}$	$6.1X10^{5}$
Ba-140 (a)		$5.0X10^{-1}$	$1.4X10^{1}$	$3.0X10^{-1}$	8.1	$2.7X10^{3}$	$7.3X10^{4}$
Be-7	Beryllium (4)	$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{1}$	$5.4X10^{2}$	$1.3X10^{4}$	$3.5X10^{5}$
Be-10		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-1}$	$1.6X10^{1}$	$8.3X10^{-4}$	$2.2X10^{-2}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Bi-205	Bismuth (83)	$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$1.5X10^{-3}$	$4.2X10^{4}$
Bi-206		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$3.8X10^{3}$	$1.0X10^{5}$
Bi-207		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	1.9	$5.2X10^{1}$
Bi-210		1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$4.6X10^{3}$	$1.2X10^{5}$
Bi-210m (a)		$6.0X10^{-1}$	$1.6X10^{1}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$2.1X10^{-5}$	$5.7X10^{-4}$
Bi-212 (a)		$7.0X10^{-1}$	$1.9X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$5.4X10^{5}$	$1.5X10^{7}$
Bk-247	Berkelium (97)	8.0	$2.2X10^{2}$	$8.0X10^{-4}$	$2.2X10^{-2}$	$3.8X10^{-2}$	1.0
Bk-249 (a)		$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{-1}$	8.1	$6.1X10^{1}$	$1.6X10^{3}$
Br-76	Bromine (35)	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$9.4X10^{4}$	$2.5X10^{6}$
Br-77		3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$2.6X10^{4}$	$7.1X10^{5}$
Br-82		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{4}$	$1.1X10^{6}$
C-11	Carbon (6)	1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.1X10^{7}$	$8.4X10^{8}$
C-14		$4.0X10^{1}$	$1.1X10^{3}$	3.0	$8.1X10^{1}$	$1.6X10^{-1}$	4.5
Ca-41	Calcium (20)	Unlimited	Unlimited	Unlimited	Unlimited	$3.1X10^{-3}$	$8.5X10^{-2}$
Ca-45		$4.0X10^{1}$	$1.1X10^{3}$	1.0	$2.7X10^{1}$	$6.6X10^{2}$	$1.8X10^{4}$
Ca-47 (a)		3.0	$8.1X10^{1}$	$3.0X10^{-1}$	8.1	$2.3X10^{4}$	$6.1X10^{5}$
Cd-109	Cadmium (48)	$3.0X10^{1}$	$8.1X10^{2}$	2.0	$5.4X10^{1}$	$9.6X10^{1}$	$2.6X10^{3}$
Cd-113m		$4.0X10^{1}$	$1.1X10^{3}$	$5.0X10^{-1}$	$1.4X10^{1}$	8.3	$2.2X10^{2}$
Cd-115 (a)		3.0	$8.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.9X10^{4}$	$5.1X10^{5}$
Cd-115m		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$9.4X10^{2}$	$2.5X10^{4}$
Ce-139	Cerium (58)	7.0	$1.9X10^{2}$	2.0	$5.4X10^{1}$	$2.5X10^{2}$	$6.8X10^{3}$
Ce-141		$2.0X10^{1}$	$5.4X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.1X10^{3}$	$2.8X10^{4}$
Ce-143		$9.0X10^{-1}$	$2.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.5X10^{4}$	$6.6X10^{5}$
Ce-144 (a)		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$1.2X10^{2}$	$3.2X10^{3}$
Cf-248	Californium (98)	$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-3}$	$1.6X10^{-1}$	$5.8X10^{1}$	$1.6X10^{3}$
Cf-249		3.0	$8.1X10^{1}$	$8.0X10^{-4}$	$2.2X10^{-2}$	$1.5X10^{-1}$	4.1
Cf-250		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{-3}$	$5.4X10^{-2}$	4.0	$1.1X10^{2}$
Cf-251		7.0	$1.9X10^{2}$	$7.0X10^{-4}$	$1.9X10^{-2}$	$5.9X10^{-2}$	1.6
Cf-252		$5.0X10^{-2}$ (h)	1.4 (h)	$3.0X10^{-3}$ (h)	$8.1X10^{-2}$ (h)	$2.0X10^{1}$	$5.4X10^{2}$
Cf-253 (a)		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{-2}$	1.1	$1.1X10^{3}$	$2.9X10^{4}$
Cf-254		$1.0X10^{-3}$	$2.7X10^{-2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$3.1X10^{2}$	$8.5X10^{3}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Cl-36	Chlorine (17)	$1.0X10^{1}$	$2.7X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.2X10^{-3}$	$3.3X10^{-2}$
Cl-38		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$4.9X10^{6}$	$1.3X10^{8}$
Cm-240	Curium (96)	$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$7.5X10^{2}$	$2.0X10^{4}$
Cm-241		2.0	$5.4X10^{1}$	1.0	$2.7X10^{1}$	$6.1X10^{2}$	$1.7X10^{4}$
Cm-242	Curium (96)	$4.0X10^{1}$	$1.1X10^{3}$	$1.0X10^{-2}$	$2.7X10^{-1}$	$1.2X10^{2}$	$3.3X10^{3}$
Cm-243		9.0	$2.4X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$1.9X10^{-3}$	$5.2X10^{1}$
Cm-244		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{-3}$	$5.4X10^{-2}$	3.0	$8.1X10^{1}$
Cm-245		9.0	$2.4X10^{2}$	$9.0X10^{-4}$	$2.4X10^{-2}$	$6.4X10^{-3}$	$1.7X10^{-1}$
Cm-246		9.0	$2.4X10^{2}$	$9.0X10^{-4}$	$2.4X10^{-2}$	$1.1X10^{-2}$	$3.1X10^{-1}$
Cm-247 (a)		3.0	$8.1X10^{1}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$3.4X10^{-6}$	$9.3X10^{-5}$
Cm-248		$2.0X10^{-2}$	$5.4X10^{-1}$	$3.0X10^{-4}$	$8.1X10^{-3}$	$1.6X10^{-5}$	$4.2X10^{-3}$
Co-55	Cobalt (27)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$1.1X10^{5}$	$3.1X10^{6}$
Co-56		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.1X10^{3}$	$3.0X10^{4}$
Co-57		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{1}$	$2.7X10^{2}$	$3.1X10^{2}$	$8.4X10^{3}$
Co-58		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.2X10^{3}$	$3.2X10^{4}$
Co-58m		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$2.2X10^{5}$	$5.9X10^{6}$
Co-60		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$4.2X10^{1}$	$1.1X10^{3}$
Cr-51	Chromium (24)	$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{1}$	$8.1X10^{2}$	$3.4X10^{3}$	$9.2X10^{4}$
Cs-129	Cesium (55)	4.0	$1.1X10^{2}$	4.0	$1.1X10^{2}$	$2.8X10^{4}$	$7.6X10^{5}$
Cs-131		$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{1}$	$8.1X10^{2}$	$3.8X10^{3}$	$1.0X10^{5}$
Cs-132		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$5.7X10^{3}$	$1.5X10^{5}$
Cs-134		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$4.8X10^{1}$	$1.3X10^{3}$
Cs-134m		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.0X10^{5}$	$8.0X10^{6}$
Cs-135		$4.0X10^{1}$	$1.1X10^{3}$	1.0	$2.7X10^{1}$	$4.3X10^{-5}$	$1.2X10^{-3}$
Cs-136		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$2.7X10^{3}$	$7.3X10^{4}$
Cs-137 (a)		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	3.2	$8.7X10^{1}$
Cu-64	Copper (29)	6.0	$1.6X10^{2}$	1.0	$2.7X10^{1}$	$1.4X10^{5}$	$3.9X10^{6}$
Cu-67		$1.0X10^{1}$	$2.7X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$2.8X10^{4}$	$7.6X10^{5}$
Dy-159	Dysprosium (66)	$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{1}$	$5.4X10^{2}$	$2.1X10^{2}$	$5.7X10^{3}$
Dy-165		$9.0X10^{-1}$	$2.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.0X10^{5}$	$8.2X10^{6}$
Dy-166 (a)		$9.0X10^{-1}$	$2.4X10^{1}$	$3.0X10^{-1}$	8.1	$8.6X10^{3}$	$2.3X10^{5}$
Er-169	Erbium (68)	$4.0X10^{1}$	$1.1X10^{3}$	1.0	$2.7X10^{1}$	$3.1X10^{3}$	$8.3X10^{4}$
Er-171		$8.0X10^{-1}$	$2.2X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$9.0X10^{4}$	$2.4X10^{6}$
Eu-147	Europium (63)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$1.4X10^{3}$	$3.7X10^{4}$
Eu-148		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$6.0X10^{2}$	$1.6X10^{4}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Eu-149		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{1}$	$5.4X10^{2}$	$3.5X10^{2}$	$9.4X10^{3}$
Eu-150 (short lived)		2.0	$5.4X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$6.1X10^{4}$	$1.6X10^{6}$
Eu-150 (long lived)		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$6.1X10^{4}$	$1.6X10^{6}$
Eu-152		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	6.5	$1.8X10^{2}$
Eu-152m		$8.0X10^{-1}$	$2.2X10^{1}$	$8.0X10^{-1}$	$2.2X10^{1}$	$8.2X10^{4}$	$2.2X10^{6}$
Eu-154		$9.0X10^{-1}$	$2.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	9.8	$2.6X10^{2}$
Eu-155		$2.0X10^{1}$	$5.4X10^{2}$	3.0	$8.1X10^{1}$	$1.8X10^{1}$	$4.9X10^{2}$
Eu-156		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$2.0X10^{3}$	$5.5X10^{4}$
F-18	Fluorine (9)	1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.5X10^{6}$	$9.5X10^{7}$
Fe-52 (a)	Iron (26)	$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$2.7X10^{5}$	$7.3X10^{6}$
Fe-55		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$8.8X10^{1}$	$2.4X10^{3}$
Fe-59		$9.0X10^{-1}$	$2.4X10^{1}$	$9.0X10^{-1}$	$2.4X10^{1}$	$1.8X10^{3}$	$5.0X10^{4}$
Fe-60 (a)		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-1}$	5.4	$7.4X10^{-4}$	$2.0X10^{-2}$
Ga-67	Gallium (31)	7.0	$1.9X10^{2}$	3.0	$8.1X10^{1}$	$2.2X10^{4}$	$6.0X10^{5}$
Ga-68		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$1.5X10^{6}$	$4.1X10^{7}$
Ga-72		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.1X10^{5}$	$3.1X10^{6}$
Gd-146 (a)	Gadolinium (64)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$6.9X10^{2}$	$1.9X10^{4}$
Gd-148		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{-3}$	$5.4X10^{-2}$	1.2	$3.2X10^{1}$
Gd-153		$1.0X10^{1}$	$2.7X10^{2}$	9.0	$2.4X10^{2}$	$1.3X10^{2}$	$3.5X10^{3}$
Gd-159		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.9X10^{4}$	$1.1X10^{6}$
Ge-68 (a)	Germanium (32)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$2.6X10^{2}$	$7.1X10^{3}$
Ge-71		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$5.8X10^{3}$	$1.6X10^{5}$
Ge-77		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.3X10^{5}$	$3.6X10^{6}$
Hf-172 (a)	Hafnium (72)	$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$4.1X10^{1}$	$1.1X10^{3}$
Hf-175		3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$3.9X10^{2}$	$1.1X10^{4}$
Hf-181		2.0	$5.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$6.3X10^{2}$	$1.7X10^{4}$
Hf-182		Unlimited	Unlimited	Unlimited	Unlimited	$8.1X10^{-6}$	$2.2X10^{-4}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Hg-194 (a)	Mercury (80)	1.0	2.7×10^{1}	1.0	2.7×10^{1}	1.3×10^{-1}	3.5
Hg-195m (a)		3.0	8.1×10^{1}	7.0×10^{-1}	1.9×10^{1}	1.5×10^{4}	4.0×10^{5}
Hg-197		2.0×10^{1}	5.4×10^{2}	1.0×10^{1}	2.7×10^{2}	9.2×10^{3}	2.5×10^{5}
Hg-197m		1.0×10^{1}	2.7×10^{2}	4.0×10^{-1}	1.1×10^{1}	2.5×10^{4}	6.7×10^{5}
Hg-203		5.0	1.4×10^{2}	1.0	2.7×10^{1}	5.1×10^{2}	1.4×10^{4}
Ho-166	Holmium (67)	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}	2.6×10^{4}	7.0×10^{5}
Ho-166m		6.0×10^{-1}	1.6×10^{1}	5.0×10^{-1}	1.4×10^{1}	6.6×10^{-2}	1.8
I-123	Iodine (53)	6.0	1.6×10^{2}	3.0	8.1×10^{1}	7.1×10^{4}	1.9×10^{6}
I-124		1.0	2.7×10^{1}	1.0	2.7×10^{1}	9.3×10^{3}	2.5×10^{5}
I-125		2.0×10^{1}	5.4×10^{2}	3.0	8.1×10^{1}	6.4×10^{2}	1.7×10^{4}
I-126		2.0	5.4×10^{1}	1.0	2.7×10^{1}	2.9×10^{3}	8.0×10^{4}
I-129		Unlimited	Unlimited	Unlimited	Unlimited	6.5×10^{-6}	1.8×10^{-4}
I-131		3.0	8.1×10^{1}	7.0×10^{-1}	1.9×10^{1}	4.6×10^{3}	1.2×10^{5}
I-132		4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}	3.8×10^{5}	1.0×10^{7}
I-133		7.0×10^{-1}	1.9×10^{1}	6.0×10^{-1}	1.6×10^{1}	4.2×10^{4}	1.1×10^{6}
I-134		3.0×10^{-1}	8.1	3.0×10^{-1}	8.1	9.9×10^{5}	2.7×10^{7}
I-135 (a)		6.0×10^{-1}	1.6×10^{1}	6.0×10^{-1}	1.6×10^{1}	1.3×10^{5}	3.5×10^{6}
In-111	Indium (49)	3.0	8.1×10^{1}	3.0	8.1×10^{1}	1.5×10^{4}	4.2×10^{5}
In-113m		4.0	1.1×10^{2}	2.0	5.4×10^{1}	6.2×10^{5}	1.7×10^{7}
In-114m (a)		1.0×10^{1}	2.7×10^{2}	5.0×10^{-1}	1.4×10^{1}	8.6×10^{2}	2.3×10^{4}
In-115m		7.0	1.9×10^{2}	1.0	2.7×10^{1}	2.2×10^{5}	6.1×10^{6}
Ir-189 (a)	Iridium (77)	1.0×10^{1}	2.7×10^{2}	1.0×10^{1}	2.7×10^{2}	1.9×10^{3}	5.2×10^{4}
Ir-190		7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}	2.3×10^{3}	6.2×10^{4}
Ir-192		1.0	2.7×10^{1}	6.0×10^{-1}	1.6×10^{1}	3.4×10^{2}	9.2×10^{3}
Ir-194		3.0×10^{-1}	8.1	3.0×10^{-1}	8.1	3.1×10^{4}	8.4×10^{5}
K-40	Potassium (19)	9.0×10^{-1}	2.4×10^{1}	9.0×10^{-1}	2.4×10^{1}	2.4×10^{-7}	6.4×10^{-6}
K-42		2.0×10^{-1}	5.4	2.0×10^{-1}	5.4	2.2×10^{5}	6.0×10^{6}
K-43		7.0×10^{-1}	1.9×10^{1}	6.0×10^{-1}	1.6×10^{1}	1.2×10^{5}	3.3×10^{6}
Kr-81	Krypton (36)	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}	7.8×10^{-4}	2.1×10^{-2}
Kr-85		1.0×10^{1}	2.7×10^{2}	1.0×10^{1}	2.7×10^{2}	1.5×10^{1}	3.9×10^{2}
Kr-85m		8.0	2.2×10^{2}	3.0	8.1×10^{1}	3.0×10^{5}	8.2×10^{6}
Kr-87		2.0×10^{-1}	5.4	2.0×10^{-1}	5.4	1.0×10^{6}	2.8×10^{7}

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
La-137	Lanthanum (57)	$3.0X10^{1}$	$8.1X10^{2}$	6.0	$1.6X10^{2}$	$1.6X10^{-3}$	$4.4X10^{-2}$
La-140		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$2.1X10^{4}$	$5.6X10^{5}$
Lu-172	Lutetium (71)	$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$4.2X10^{3}$	$1.1X10^{5}$
Lu-173		8.0	$2.2X10^{2}$	8.0	$2.2X10^{2}$	$5.6X10^{1}$	$1.5X10^{3}$
Lu-174		9.0	$2.4X10^{2}$	9.0	$2.4X10^{2}$	$2.3X10^{1}$	$6.2X10^{2}$
Lu-174m		$2.0X10^{1}$	$5.4X10^{2}$	$1.0X10^{1}$	$2.7X10^{2}$	$2.0X10^{2}$	$5.3X10^{3}$
Lu-177		$3.0X10^{1}$	$8.1X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$4.1X10^{3}$	$1.1X10^{5}$
Mg-28 (a)	Magnesium (12)	$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$2.0X10^{5}$	$5.4X10^{6}$
Mn-52	Manganese (25)	$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.6X10^{4}$	$4.4X10^{5}$
Mn-53		Unlimited	Unlimited	Unlimited	Unlimited	$6.8X10^{-5}$	$1.8X10^{-3}$
Mn-54		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$2.9X10^{2}$	$7.7X10^{3}$
Mn-56		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$8.0X10^{5}$	$2.2X10^{7}$
Mo-93	Molybdenum (42)	$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{1}$	$5.4X10^{2}$	$4.1X10^{-2}$	1.1
Mo-99 (a)		1.0	$2.7X10^{1}$	$6.0X10^{-1}$ (i)	$1.6X10^{1}$ (i)	$1.8X10^{4}$	$4.8X10^{5}$
–13	Nitrogen (7)	$9.0X10^{-1}$	$2.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$5.4X10^{7}$	$1.5X10^{9}$
Na-22	Sodium (11)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$2.3X10^{2}$	$6.3X10^{3}$
Na-24		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$3.2X10^{5}$	$8.7X10^{6}$
Nb-93m	Niobium (41)	$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{1}$	$8.1X10^{2}$	8.8	$2.4X10^{2}$
Nb-94		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$6.9X10^{-3}$	$1.9X10^{-1}$
Nb-95		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.5X10^{3}$	$3.9X10^{4}$
Nb-97		$9.0X10^{-1}$	$2.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$9.9X10^{5}$	$2.7X10^{7}$
Nd-147	Neodymium (60)	6.0	$1.6X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.0X10^{3}$	$8.1X10^{4}$
Nd-149		$6.0X10^{-1}$	$1.6X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$4.5X10^{5}$	$1.2X10^{7}$
Ni-59	Nickel (28)	Unlimited	Unlimited	Unlimited	Unlimited	$3.0X10^{-3}$	$8.0X10^{-2}$
Ni-63		$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{1}$	$8.1X10^{2}$	2.1	$5.7X10^{1}$
Ni-65		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$7.1X10^{5}$	$1.9X10^{7}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Np-235	Neptunium (93)	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$5.2X10^{1}$	$1.4X10^{3}$
Np-236 (short-lived)		$2.0X10^{1}$	$5.4X10^{2}$	2.0	$5.4X10^{1}$	$4.7X10^{-4}$	$1.3X10^{-2}$
Np-236 (long-lived)		9.0	$2.4X10^{2}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$4.7X10^{-4}$	$1.3X10^{-2}$
Np-237		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{-3}$	$5.4X10^{-2}$	$2.6X10^{-5}$	$7.1X10^{-4}$
Np-239		7.0	$1.9X10^{2}$	$4.0X10^{-1}$	$1.1X10^{1}$	$8.6X10^{3}$	$2.3X10^{5}$
Os-185	Osmium (76)	1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$2.8X10^{2}$	$7.5X10^{3}$
Os-191		$1.0X10^{1}$	$2.7X10^{2}$	2.0	$5.4X10^{1}$	$1.6X10^{3}$	$4.4X10^{4}$
Os-191m		$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{1}$	$8.1X10^{2}$	$4.6X10^{4}$	$1.3X10^{6}$
Os-193		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.0X10^{4}$	$5.3X10^{5}$
Os-194 (a)		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.1X10^{1}$	$3.1X10^{2}$
P-32	Phosphorus (15)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$1.1X10^{4}$	$2.9X10^{5}$
P-33		$4.0X10^{1}$	$1.1X10^{3}$	1.0	$2.7X10^{1}$	$5.8X10^{3}$	$1.6X10^{5}$
Pa-230 (a)	Protactinium (91)	2.0	$5.4X10^{1}$	$7.0X10^{-2}$	1.9	$1.2X10^{3}$	$3.3X10^{4}$
Pa-231		4.0	$1.1X10^{2}$	$4.0X10^{-4}$	$1.1X10^{-2}$	$1.7X10^{-3}$	$4.7X10^{-2}$
Pa-233		5.0	$1.4X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$7.7X10^{2}$	$2.1X10^{4}$
Pb-201	Lead (82)	1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$6.2X10^{4}$	$1.7X10^{6}$
Pb-202		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{1}$	$5.4X10^{2}$	$1.2X10^{-4}$	$3.4X10^{-3}$
Pb-203		4.0	$1.1X10^{2}$	3.0	$8.1X10^{1}$	$1.1X10^{4}$	$3.0X10^{5}$
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	$4.5X10^{-6}$	$1.2X10^{-4}$
Pb-210 (a)		1.0	$2.7X10^{1}$	$5.0X10^{-2}$	1.4	2.8	$7.6X10^{1}$
Pb-212 (a)		$7.0X10^{-1}$	$1.9X10^{1}$	$2.0X10^{-1}$	5.4	$5.1X10^{4}$	$1.4X10^{6}$
Pd-103 (a)	Palladium (46)	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$2.8X10^{3}$	$7.5X10^{4}$
Pd-107		Unlimited	Unlimited	Unlimited	Unlimited	$1.9X10^{-5}$	$5.1X10^{-4}$
Pd-109		2.0	$5.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$7.9X10^{4}$	$2.1X10^{6}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Pm-143	Promethium (61)	3.0	8.1×10^{1}	3.0	8.1×10^{1}	1.3×10^{2}	3.4×10^{3}
Pm-144		7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}	9.2×10^{1}	2.5×10^{3}
Pm-145		3.0×10^{1}	8.1×10^{2}	1.0×10^{1}	2.7×10^{2}	5.2	1.4×10^{2}
Pm-147		4.0×10^{1}	1.1×10^{3}	2.0	5.4×10^{1}	3.4×10^{1}	9.3×10^{2}
Pm-148m (a)		8.0×10^{-1}	2.2×10^{1}	7.0×10^{-1}	1.9×10^{1}	7.9×10^{2}	2.1×10^{4}
Pm-149		2.0	5.4×10^{1}	6.0×10^{-1}	1.6×10^{1}	1.5×10^{4}	4.0×10^{5}
Pm-151		2.0	5.4×10^{1}	6.0×10^{-1}	1.6×10^{1}	2.7×10^{4}	7.3×10^{5}
Po-210	Polonium (84)	4.0×10^{1}	1.1×10^{3}	2.0×10^{-2}	5.4×10^{-1}	1.7×10^{2}	4.5×10^{3}
Pr-142	Praseodymium (59)	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}	4.3×10^{4}	1.2×10^{6}
Pr-143		3.0	8.1×10^{1}	6.0×10^{-1}	1.6×10^{1}	2.5×10^{3}	6.7×10^{4}
Pt-188 (a)	Platinum (78)	1.0	2.7×10^{1}	8.0×10^{-1}	2.2×10^{1}	2.5×10^{3}	6.8×10^{4}
Pt-191		4.0	1.1×10^{2}	3.0	8.1×10^{1}	8.7×10^{3}	2.4×10^{5}
Pt-193		4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}	1.4	3.7×10^{1}
Pt-193m		4.0×10^{1}	1.1×10^{3}	5.0×10^{-1}	1.4×10^{1}	5.8×10^{3}	1.6×10^{5}
Pt-195m		1.0×10^{1}	2.7×10^{2}	5.0×10^{-1}	1.4×10^{1}	6.2×10^{3}	1.7×10^{5}
Pt-197		2.0×10^{1}	5.4×10^{2}	6.0×10^{-1}	1.6×10^{1}	3.2×10^{4}	8.7×10^{5}
Pt-197m		1.0×10^{1}	2.7×10^{2}	6.0×10^{-1}	1.6×10^{1}	3.7×10^{5}	1.0×10^{7}
Pu-236	Plutonium (94)	3.0×10^{1}	8.1×10^{2}	3.0×10^{-3}	8.1×10^{-2}	2.0×10^{1}	5.3×10^{2}
Pu-237		2.0×10^{1}	5.4×10^{2}	2.0×10^{1}	5.4×10^{2}	4.5×10^{2}	1.2×10^{4}
Pu-238		1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}	6.3×10^{-1}	1.7×10^{1}
Pu-239		1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}	2.3×10^{-3}	6.2×10^{-2}
Pu-240		1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}	8.4×10^{-3}	2.3×10^{-1}
Pu-241 (a)		4.0×10^{1}	1.1×10^{3}	6.0×10^{-2}	1.6	3.8	1.0×10^{2}
Pu-242		1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}	1.5×10^{-4}	3.9×10^{-3}
Pu-244 (a)		4.0×10^{-1}	1.1×10^{1}	1.0×10^{-3}	2.7×10^{-2}	6.7×10^{-7}	1.8×10^{-5}
Ra-223 (a)	Radium (88)	4.0×10^{-1}	1.1×10^{1}	7.0×10^{-3}	1.9×10^{-1}	1.9×10^{3}	5.1×10^{4}
Ra-224 (a)		4.0×10^{-1}	1.1×10^{1}	2.0×10^{-2}	5.4×10^{-1}	5.9×10^{3}	1.6×10^{5}
Ra-225 (a)		2.0×10^{-1}	5.4	4.0×10^{-3}	1.1×10^{-1}	1.5×10^{3}	3.9×10^{4}
Ra-226 (a)		2.0×10^{-1}	5.4	3.0×10^{-3}	8.1×10^{-2}	3.7×10^{-2}	1.0
Ra-228 (a)		6.0×10^{-1}	1.6×10^{1}	2.0×10^{-2}	5.4×10^{-1}	1.0×10^{1}	2.7×10^{2}

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Rb-81	Rubidium (37)	2.0	$5.4X10^{1}$	$8.0X10^{-1}$	$2.2X10^{1}$	$3.1X10^{5}$	$8.4X10^{6}$
Rb-83 (a)		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$6.8X10^{2}$	$1.8X10^{4}$
Rb-84		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.8X10^{3}$	$4.7X10^{4}$
Rb-86		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$3.0X10^{3}$	$8.1X10^{4}$
Rb-87		Unlimited	Unlimited	Unlimited	Unlimited	$3.2X10^{-9}$	$8.6X10^{-8}$
Rb(nat)		Unlimited	Unlimited	Unlimited	Unlimited	$6.7X10^{6}$	$1.8X10^{8}$
Re-184	Rhenium (75)	1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$6.9X10^{2}$	$1.9X10^{4}$
Re-184m		3.0	$8.1X10^{1}$	1.0	$2.7X10^{1}$	$1.6X10^{2}$	$4.3X10^{3}$
Re-186		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$6.9X10^{3}$	$1.9X10^{5}$
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	$1.4X10^{-9}$	$3.8X10^{-8}$
Re-188		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$3.6X10^{4}$	$9.8X10^{5}$
Re-189 (a)		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.5X10^{4}$	$6.8X10^{5}$
Re(nat)		Unlimited	Unlimited	Unlimited	Unlimited	0.0	$2.4X10^{-8}$
Rh-99	Rhodium (45)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$3.0X10^{3}$	$8.2X10^{4}$
Rh-101		4.0	$1.1X10^{2}$	3.0	$8.1X10^{1}$	$4.1X10^{1}$	$1.1X10^{3}$
Rh-102		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$4.5X10^{1}$	$1.2X10^{3}$
Rh-102m		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$2.3X10^{2}$	$6.2X10^{3}$
Rh-103m		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$1.2X10^{6}$	$3.3X10^{7}$
Rh-105		$1.0X10^{1}$	$2.7X10^{2}$	$8.0X10^{-1}$	$2.2X10^{1}$	$3.1X10^{4}$	$8.4X10^{5}$
Rn-222 (a)	Radon (86)	$3.0X10^{-1}$	8.1	$4.0X10^{-3}$	$1.1X10^{-1}$	$5.7X10^{3}$	$1.5X10^{5}$
Ru-97	Ruthenium (44)	5.0	$1.4X10^{2}$	5.0	$1.4X10^{2}$	$1.7X10^{4}$	$4.6X10^{5}$
Ru-103 (a)		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$1.2X10^{3}$	$3.2X10^{4}$
Ru-105		1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.5X10^{5}$	$6.7X10^{6}$
Ru-106 (a)		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$1.2X10^{2}$	$3.3X10^{3}$
S-35	Sulphur (16)	$4.0X10^{1}$	$1.1X10^{3}$	3.0	$8.1X10^{1}$	$1.6X10^{3}$	$4.3X10^{4}$
Sb-122	Antimony (51)	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.5X10^{4}$	$4.0X10^{5}$
Sb-124		$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$6.5X10^{2}$	$1.7X10^{4}$
Sb-125		2.0	$5.4X10^{1}$	1.0	$2.7X10^{1}$	$3.9X10^{1}$	$1.0X10^{3}$
Sb-126		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$3.1X10^{3}$	$8.4X10^{4}$
Sc-44	Scandium (21)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$6.7X10^{5}$	$1.8X10^{7}$
Sc-46		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$1.3X10^{3}$	$3.4X10^{4}$
Sc-47		$1.0X10^{1}$	$2.7X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$3.1X10^{4}$	$8.3X10^{5}$
Sc-48		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$5.5X10^{4}$	$1.5X10^{6}$
Se-75	Selenium (34)	3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$5.4X10^{2}$	$1.5X10^{4}$
Se-79		$4.0X10^{1}$	$1.1X10^{3}$	2.0	$5.4X10^{1}$	$2.6X10^{-3}$	$7.0X10^{-2}$
Si-31	Silicon (14)	$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.4X10^{6}$	$3.9X10^{7}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Si-32		$4.0X10^{1}$	$1.1X10^{3}$	$5.0X10^{-1}$	$1.4X10^{1}$	3.9	$1.1X10^{2}$
Sm-145	Samarium (62)	$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{1}$	$2.7X10^{2}$	$9.8X10^{1}$	$2.6X10^{3}$
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	$8.5X10^{-1}$	$2.3X10^{-8}$
Sm-151		$4.0X10^{1}$	$1.1X10^{3}$	$1.0X10^{1}$	$2.7X10^{2}$	$9.7X10^{-1}$	$2.6X10^{1}$
Sm-153		9.0	$2.4X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.6X10^{4}$	$4.4X10^{5}$
Sn-113 (a)	Tin (50)	4.0	$1.1X10^{2}$	2.0	$5.4X10^{1}$	$3.7X10^{2}$	$1.0X10^{4}$
Sn-117m		7.0	$1.9X10^{2}$	$4.0X10^{-1}$	$1.1X10^{1}$	$3.0X10^{3}$	$8.2X10^{4}$
Sn-119m		$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{1}$	$8.1X10^{2}$	$1.4X10^{2}$	$3.7X10^{3}$
Sn-121m (a)		$4.0X10^{1}$	$1.1X10^{3}$	$9.0X10^{-1}$	$2.4X10^{1}$	2.0	$5.4X10^{1}$
Sn-123		$8.0X10^{-1}$	$2.2X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.0X10^{2}$	$8.2X10^{3}$
Sn-125		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{3}$	$1.1X10^{5}$
Sn-126 (a)		$6.0X10^{-1}$	$1.6X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.0X10^{-3}$	$2.8X10^{-2}$
Sr-82 (a)	Strontium (38)	$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$2.3X10^{3}$	$6.2X10^{4}$
Sr-85		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$8.8X10^{2}$	$2.4X10^{4}$
Sr-85m		5.0	$1.4X10^{2}$	5.0	$1.4X10^{2}$	$1.2X10^{6}$	$3.3X10^{7}$
Sr-87m		3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$4.8X10^{5}$	$1.3X10^{7}$
Sr-89		$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.1X10^{3}$	$2.9X10^{4}$
Sr-90 (a)		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	5.1	$1.4X10^{2}$
Sr-91 (a)		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.3X10^{5}$	$3.6X10^{6}$
Sr-92 (a)		1.0	$2.7X10^{1}$	$3.0X10^{-1}$	8.1	$4.7X10^{5}$	$1.3X10^{7}$
T(H-3)	Tritium (1)	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$3.6X10^{2}$	$9.7X10^{3}$
Ta-178 (long-lived)	Tantalum (73)	1.0	$2.7X10^{1}$	$8.0X10^{-1}$	$2.2X10^{1}$	$4.2X10^{6}$	$1.1X10^{8}$
Ta-179		$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{1}$	$8.1X10^{2}$	$4.1X10^{1}$	$1.1X10^{3}$
Ta-182		$9.0X10^{-1}$	$2.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$2.3X10^{2}$	$6.2X10^{3}$
Tb-157	Terbium (65)	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$5.6X10^{-1}$	$1.5X10^{1}$
Tb-158		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$5.6X10^{-1}$	$1.5X10^{1}$
Tb-160		1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$4.2X10^{2}$	$1.1X10^{4}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Tc-95m (a)	Technetium (43)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$8.3X10^{2}$	$2.2X10^{4}$
Tc-96		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.2X10^{4}$	$3.2X10^{5}$
Tc-96m (a)		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.4X10^{6}$	$3.8X10^{7}$
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	$5.2X10^{-5}$	$1.4X10^{-3}$
Tc-97m		$4.0X10^{1}$	$1.1X10^{3}$	1.0	$2.7X10^{1}$	$5.6X10^{2}$	$1.5X10^{4}$
Tc-98		$8.0X10^{-1}$	$2.2X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$3.2X10^{-5}$	$8.7X10^{-4}$
Tc-99		$4.0X10^{1}$	$1.1X10^{3}$	$9.0X10^{-1}$	$2.4X10^{1}$	$6.3X10^{-4}$	$1.7X10^{-2}$
Tc-99m		$1.0X10^{1}$	$2.7X10^{2}$	4.0	$1.1X10^{2}$	$1.9X10^{5}$	$5.3X10^{6}$
Te-121	Tellurium (52)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$2.4X10^{3}$	$6.4X10^{4}$
Te-121m		5.0	$1.4X10^{2}$	3.0	$8.1X10^{1}$	$2.6X10^{2}$	$7.0X10^{3}$
Te-123m		8.0	$2.2X10^{2}$	1.0	$2.7X10^{1}$	$3.3X10^{2}$	$8.9X10^{3}$
Te-125m		$2.0X10^{1}$	$5.4X10^{2}$	$9.0X10^{-1}$	$2.4X10^{1}$	$6.7X10^{2}$	$1.8X10^{4}$
Te-127		$2.0X10^{1}$	$5.4X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$9.8X10^{4}$	$2.6X10^{6}$
Te-127m (a)		$2.0X10^{1}$	$5.4X10^{2}$	$5.0X10^{-1}$	$1.4X10^{1}$	$3.5X10^{2}$	$9.4X10^{3}$
Te-129		$7.0X10^{-1}$	$1.9X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$7.7X10^{5}$	$2.1X10^{7}$
Te-129m (a)		$8.0X10^{-1}$	$2.2X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.1X10^{3}$	$3.0X10^{4}$
Te-131m (a)		$7.0X10^{-1}$	$1.9X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$3.0X10^{4}$	$8.0X10^{5}$
Te-132 (a)		$5.0X10^{-1}$	$1.4X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.1X10^{4}$	$8.0X10^{5}$
Th-227	Thorium (90)	$1.0X10^{1}$	$2.7X10^{2}$	$5.0X10^{-3}$	$1.4X10^{-1}$	$1.1X10^{3}$	$3.1X10^{4}$
Th-228 (a)		$5.0X10^{-1}$	$1.4X10^{1}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$3.0X10^{1}$	$8.2X10^{2}$
Th-229		5.0	$1.4X10^{2}$	$5.0X10^{-4}$	$1.4X10^{-2}$	$7.9X10^{-3}$	$2.1X10^{-1}$
Th-230		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$7.6X10^{-4}$	$2.1X10^{-2}$
Th-231	Thorium (90)	$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$2.0X10^{4}$	$5.3X10^{5}$
Th-232		Unlimited	Unlimited	Unlimited	Unlimited	$4.0X10^{-9}$	$1.1X10^{-7}$
Th-234 (a)		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$8.6X10^{2}$	$2.3X10^{4}$
Th(nat)		Unlimited	Unlimited	Unlimited	Unlimited	$8.1X10^{-9}$	$2.2X10^{-7}$
Ti-44 (a)	Titanium (22)	$5.0X10^{-1}$	$1.4X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	6.4	$1.7X10^{2}$
Tl-200	Thallium (81)	$9.0X10^{-1}$	$2.4X10^{1}$	$9.0X10^{-1}$	$2.4X10^{1}$	$2.2X10^{4}$	$6.0X10^{5}$
Tl-201		$1.0X10^{1}$	$2.7X10^{2}$	4.0	$1.1X10^{2}$	$7.9X10^{3}$	$2.1X10^{5}$
Tl-202		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$2.0X10^{3}$	$5.3X10^{4}$
Tl-204		$1.0X10^{1}$	$2.7X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$1.7X10^{1}$	$4.6X10^{2}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Tm-167	Thulium (69)	7.0	$1.9X10^{2}$	$8.0X10^{-1}$	$2.2X10^{1}$	$3.1X10^{3}$	$8.5X10^{4}$
Tm-170		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.2X10^{2}$	$6.0X10^{3}$
Tm-171		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$
U-230 (fast lung absorption) (a)(d)	Uranium (92)	$4.0X10^{1}$	$1.1X10^{3}$	$1.0X10^{-1}$	2.7	$1.0X10^{3}$	$2.7X10^{4}$
U-230 (medium lung absorption) (a)(e)		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{-3}$	$1.1X10^{-1}$	$1.0X10^{3}$	$2.7X10^{4}$
U-230 (slow lung absorption) (a)(f)		$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{-3}$	$8.1X10^{-2}$	$1.0X10^{3}$	$2.7X10^{4}$
U-232 (fast lung absorption) (d)		$4.0X10^{1}$	$1.1X10^{3}$	$1.0X10^{-2}$	$2.7X10^{-1}$	$8.3X10^{-1}$	$2.2X10^{1}$
U-232 (medium lung absorption) (e)		$4.0X10^{1}$	$1.1X10^{3}$	$7.0X10^{-3}$	$1.9X10^{-1}$	$8.3X10^{-1}$	$2.2X10^{1}$
U-232 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$8.3X10^{-1}$	$2.2X10^{1}$
U-233 (fast lung absorption) (d)	Uranium (92)	$4.0X10^{1}$	$1.1X10^{3}$	$9.0X10^{-2}$	2.4	$3.6X10^{-4}$	$9.7X10^{-3}$
U-233 (medium lung absorption) (e)		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$3.6X10^{-4}$	$9.7X10^{-3}$
U-233 (slow lung absorption) (f)		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-3}$	$1.6X10^{-1}$	$3.6X10^{-4}$	$9.7X10^{-3}$
U-234 (fast lung absorption) (d)		$4.0X10^{1}$	$1.1X10^{3}$	$9.0X10^{-2}$	2.4	$2.3X10^{-4}$	$6.2X10^{-3}$
U-234 (medium lung absorption) (e)		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$2.3X10^{-4}$	$6.2X10^{-3}$
U-234 (slow lung absorption) (f)		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-3}$	$1.6X10^{-1}$	$2.3X10^{-4}$	$6.2X10^{-3}$
U-235 (all lung absorption types) (a),(d),(e),(f)	Uranium (92) (Continued)	Unlimited	Unlimited	Unlimited	Unlimited	$8.0X10^{-8}$	$2.2X10^{-6}$
U-236 (fast lung absorption) (d)		Unlimited	Unlimited	Unlimited	Unlimited	$2.4X10^{-6}$	$6.5X10^{-5}$
U-236 (medium		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$2.4X10^{-6}$	$6.5X10^{-5}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
lung absorption) (e)							
U-236 (slow lung absorption) (f)		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-3}$	$1.6X10^{-1}$	$2.4X10^{-6}$	$6.5X10^{-5}$
U-238 (all lung absorption types) (d),(e),(f)		Unlimited	Unlimited	Unlimited	Unlimited	$1.2X10^{-8}$	$3.4X10^{-7}$
U (nat)		Unlimited	Unlimited	Unlimited	Unlimited	$2.6X10^{-8}$	$7.1X10^{-7}$
U (enriched to 20% or less)(g)		Unlimited	Unlimited	Unlimited	Unlimited	N/A	N/A
U (dep)		Unlimited	Unlimited	Unlimited	Unlimited	0.0	(See Table A-3)
V-48	Vanadium (23)	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$6.3X10^{3}$	$1.7X10^{5}$
V-49		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{2}$	$8.1X10^{3}$
W-178 (a)	Tungsten (74)	9.0	$2.4X10^{2}$	5.0	$1.4X10^{2}$	$1.3X10^{3}$	$3.4X10^{4}$
W-181		$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{1}$	$8.1X10^{2}$	$2.2X10^{2}$	$6.0X10^{3}$
W-185		$4.0X10^{1}$	$1.1X10^{3}$	$8.0X10^{-1}$	$2.2X10^{1}$	$3.5X10^{2}$	$9.4X10^{3}$
W-187		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.6X10^{4}$	$7.0X10^{5}$
W-188 (a)		$4.0X10^{-1}$	$1.1X10^{1}$	$3.0X10^{-1}$	8.1	$3.7X10^{2}$	$1.0X10^{4}$
Xe-122 (a)	Xenon (54)	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$4.8X10^{4}$	$1.3X10^{6}$
Xe-123		2.0	$5.4X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$4.4X10^{5}$	$1.2X10^{7}$
Xe-127		4.0	$1.1X10^{2}$	2.0	$5.4X10^{1}$	$1.0X10^{3}$	$2.8X10^{4}$
Xe-131m		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$3.1X10^{3}$	$8.4X10^{4}$
Xe-133		$2.0X10^{1}$	$5.4X10^{2}$	$1.0X10^{1}$	$2.7X10^{2}$	$6.9X10^{3}$	$1.9X10^{5}$
Xe-135		3.0	$8.1X10^{1}$	2.0	$5.4X10^{1}$	$9.5X10^{4}$	$2.6X10^{6}$

Table A-1. A_1 and A_2 Values for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific activity (TBq/g)	Specific activity (Ci/g)
Y-87 (a)	Yttrium (39)	1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.7X10^{4}$	$4.5X10^{5}$
Y-88		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$5.2X10^{2}$	$1.4X10^{4}$
Y-90		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$2.0X10^{4}$	$5.4X10^{5}$
Y-91		$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$9.1X10^{2}$	$2.5X10^{4}$
Y-91m		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$1.5X10^{6}$	$4.2X10^{7}$
Y-92		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$3.6X10^{5}$	$9.6X10^{6}$
Y-93		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.2X10^{5}$	$3.3X10^{6}$
Yb-169	Ytterbium (79)	4.0	$1.1X10^{2}$	1.0	$2.7X10^{1}$	$8.9X10^{2}$	$2.4X10^{4}$
Yb-175		$3.0X10^{1}$	$8.1X10^{2}$	$9.0X10^{-1}$	$2.4X10^{1}$	$6.6X10^{3}$	$1.8X10^{5}$
Zn-65	Zinc (30)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$3.0X10^{2}$	$8.2X10^{3}$
Zn-69		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.8X10^{6}$	$4.9X10^{7}$
Zn-69m (a)		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.2X10^{5}$	$3.3X10^{6}$
Zr-88	Zirconium (40)	3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$6.6X10^{2}$	$1.8X10^{4}$
Zr-93		Unlimited	Unlimited	Unlimited	Unlimited	$9.3X10^{-5}$	$2.5X10^{-3}$
Zr-95 (a)		2.0	$5.4X10^{1}$	$8.0X10^{-1}$	$2.2X10^{1}$	$7.9X10^{2}$	$2.1X10^{4}$
Zr-97 (a)		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$7.1X10^{4}$	$1.9X10^{6}$

NOTES

(a) A_1 and/or A_2 values include contributions from daughter nuclides with half-lives less than 10 days

(b) Parent nuclides and their progeny included in secular equilibrium are listed in the following:

Sr-90	Y-90
Zr-93	Nb-93m
Zr-97	Nb-97
Ru-106	Rh-106
Cs-137	Ba-137m
Ce-134	La-134
Ce-144	Pr-144
Ba-140	La-140
Bi-212	Tl-208 (0.36), Po-212 (0.64)
Pb-210	Bi-210, Po-210
Pb-212	Bi-212, Tl-208 (0.36), Po-212 (0.64)
Rn-220	Po-216
Rn-222	Po-218, Pb-214, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Ra-228	Ac-228
Th-226	Ra-222, Rn-218, Po-214
Th-228	Ra-224, Rn-220, Po-216, Pb212, Bi-212, Tl208 (0.36), Po-212 (0.64)
Th-229	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
Th-nat	Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-234	Pa-234m
U-230	Th-226, Ra-222, Rn-218, Po-214

U-232	Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
U-235	Th-231
U-238	Th-234, Pa-234m
U-nat	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214,
U-240	Np-240m
Np-237	Pa-233
Am-242m	Am-242
Am-243	Np-239

©) The quantity may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed distance from the source.

(d) These values apply only to compounds of uranium that take the chemical form of UF_6, UO_2F_2 and $UO_2(NO_3)_2$ in both normal and accident conditions of transport.

(e) These values apply only to compounds of uranium that take the chemical form of UO_3, UF_4, UCl_4, and hexavalent compounds in both normal and accident conditions of transport.

(f) These values apply to all compounds of uranium other than those specified in (d) and (e), above.

(g) These values apply to unirradiated uranium only.

(h) A_1 = 0.1 TBq (2.7Ci) and A_2 = 0.001 TBq (0.027 Ci) for Cf-252 for domestic use.

(i) A_2 = 0.74 TBq (20 Ci) for Mo-99 for domestic use.

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Ac-225 (a)	Actinium (89)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Ac-227 (a)		$1.0X10^{-1}$	$2.7X10^{-12}$	$1.0X10^{3}$	$2.7X10^{-8}$
Ac-228		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ag-105	Silver (47)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ag-108m (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ag-110m (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ag-111		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Al-26	Aluminum (13)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Am-241	Americium (95)	1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Am-242m (a)		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Am-243 (a)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Ar-37	Argon (18)	$1.0X10^{6}$	$2.7X10^{-5}$	$1.0X10^{8}$	$2.7X10^{-3}$
Ar-39		$1.0X10^{7}$	$2.7X10^{-4}$	$1.0X10^{4}$	$2.7X10^{-7}$
Ar-41		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{9}$	$2.7X10^{-2}$
As-72	Arsenic (33)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
As-73		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
As-74		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
As-76		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
As-77		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
At-211 (a)	Astatine (85)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Au-193	Gold (79)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Au-194		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Au-195		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Au-198		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Au-199		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ba-131 (a)	Barium (56)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ba-133		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ba-133m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ba-140 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignme nt (Ci)
Be-7	Beryllium (4)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Be-10		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$
Bi-205	Bismuth (83)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Bi-206		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Bi-207		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Bi-210		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Bi-210m (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Bi-212 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Bk-247	Berkelium (97)	1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Bk-249 (a)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Br-76	Bromine (35)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Br-77		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Br-82		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
C-11	Carbon (6)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
C-14		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ca-41	Calcium (20)	$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ca-45		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ca-47 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cd-109	Cadmium (48)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cd-113m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cd-115 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cd-115m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ce-139	Cerium (58)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ce-141		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ce-143		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ce-144 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignme nt (Ci)
Cf-248	Californium (98)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cf-249		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Cf-250		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cf-251		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Cf-252		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cf-253 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cf-254		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Cl-36	Chlorine (17)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cl-38		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cm-240	Curium (96)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cm-241		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cm-242		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cm-243		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cm-244		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cm-245		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Cm-246		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Cm-247 (a)		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cm-248		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Co-55	Cobalt (27)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Co-56		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Co-57		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Co-58		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Co-58m		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Co-60		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cr-51	Chromium (24)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Cs-129	Cesium (55)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cs-131		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cs-132		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cs-134		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cs-134m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cs-135		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Cs-136		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cs-137 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cu-64	Copper (29)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cu-67		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Dy-159	Dysprosium (66)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Dy-165		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Dy-166 (a)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Er-169	Erbium (68)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Er-171		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-147	Europium (63)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-148		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-149		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Eu-150 (short lived)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-150 (long lived)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-152		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-152 m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-154		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-155		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Eu-156		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
F-18	Fluorine (9)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Fe-52 (a)	Iron (26)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Fe-55		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$
Fe-59		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Fe-60 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ga-67	Gallium (31)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ga-68		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ga-72		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Gd-146 (a)	Gadolinium (64)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Gd-148		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Gd-153		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Gd-159		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ge-68 (a)	Germanium (32)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ge-71		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{8}$	$2.7X10^{-3}$
Ge-77		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Hf-172 (a)	Hafnium (72)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hf-175		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hf-181		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hf-182		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hg-194 (a)	Mercury (80)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hg-195m (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hg-197		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Hg-197m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hg-203		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ho-166	Holmium (67)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ho-166m		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
I-123	Iodine (53)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
I-124		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
I-125		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
I-126		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
I-129		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
I-131		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
I-132		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
I-133		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
I-134		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
I-135 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
In-111	Indium (49)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
In-113m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
In-114m (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
In-115m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ir-189 (a)	Iridium (77)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ir-190		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ir-192		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Ir-194		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
K-40	Potassium (19)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
K-42		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
K-43		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Kr-81	Krypton (36)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Kr-85		$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{4}$	$2.7X10^{-7}$
Kr-85m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{10}$	$2.7X10^{-1}$
Kr-87		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{9}$	$2.7X10^{-2}$
La-137	Lanthanum (57)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
La-140		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Lu-172	Lutetium (71)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Lu-173		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Lu-174		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Lu-174m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Lu-177		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Mg-28 (a)	Magnesium (12)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Mn-52	Manganese (25)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Mn-53		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{9}$	$2.7X10^{-2}$
Mn-54		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Mn-56		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Mo-93	Molybdenum (42)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{8}$	$2.7X10^{-3}$
Mo-99 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
–13	Nitrogen (7)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{9}$	$2.7X10^{-2}$
Na-22	Sodium (11)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Na-24		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Nb-93m	Niobium (41)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Nb-94		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Nb-95		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Nb-97		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Nd-147	Neodymium (60)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Nd-149		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ni-59	Nickel (28)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{8}$	$2.7X10^{-3}$
Ni-63		$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{8}$	$2.7X10^{-3}$
Ni-65		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Np-235	Neptunium (93)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Np-236 (short-lived)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Np-236 (long-lived)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Np-237		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Np-239		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Os-185	Osmium (76)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Os-191		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Os-191m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Os-193		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Os-194 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
P-32	Phosphorus (15)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
P-33		$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{8}$	$2.7X10^{-3}$
Pa-230 (a)	Protactinium (91)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pa-231		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Pa-233		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pb-201	Lead (82)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pb-202		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pb-203		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pb-205		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pb-210 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pb-212 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Pd-103 (a)	Palladium (46)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{8}$	$2.7X10^{-3}$
Pd-107		$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{8}$	$2.7X10^{-3}$
Pd-109		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pm-143	Promethium (61)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pm-144		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pm-145		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pm-147		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pm-148m (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pm-149		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pm-151		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Po-210	Polonium (84)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pr-142	Praseodymium (59)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Pr-143		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Pt-188 (a)	Platinum (78)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pt-191		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pt-193		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pt-193m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pt-195m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pt-197		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pt-197m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pu-236	Plutonium (94)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pu-237		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pu-238		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pu-239		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pu-240		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Pu-241 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Pu-242		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pu-244 (a)		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Ra-223 (a)	Radium (88)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ra-224 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ra-225 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ra-226 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Ra-228 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Rb-81	Rubidium (37)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rb-83 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rb-84		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rb-86		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Rb-87		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Rb(nat)		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Re-184	Rhenium (75)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Re-184m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Re-186		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Re-187		$1.0X10^{6}$	$2.7X10^{-5}$	$1.0X10^{9}$	$2.7X10^{-2}$
Re-188		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Re-189 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Re(nat)		$1.0X10^{6}$	$2.7X10^{-5}$	$1.0X10^{9}$	$2.7X10^{-2}$
Rh-99	Rhodium (45)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rh-101		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Rh-102		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rh-102m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rh-103m		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{8}$	$2.7X10^{-3}$
Rh-105		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Rn-222 (a)	Radon (86)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{8}$	$2.7X10^{-3}$
Ru-97	Ruthenium (44)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ru-103 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ru-105		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ru-106 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
S-35	Sulphur (16)	$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{8}$	$2.7X10^{-3}$
Sb-122	Antimony (51)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{4}$	$2.7X10^{-7}$
Sb-124		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sb-125		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sb-126		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sc-44	Scandium (21)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sc-46		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sc-47		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sc-48		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Se-75	Selenium (34)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Se-79		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Si-31	Silicon (14)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Si-32		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sm-145	Samarium (62)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Sm-147		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Sm-151		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{8}$	$2.7X10^{-3}$
Sm-153		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sn-113 (a)	Tin (50)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Sn-117m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sn-119m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Sn-121m (a)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Sn-123		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sn-125		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sn-126 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sr-82 (a)	Strontium (38)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sr-85		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sr-85m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Sr-87m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sr-89		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sr-90 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{4}$	$2.7X10^{-7}$
Sr-91 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sr-92 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
T(H-3)	Tritium (1)	$1.0X10^{6}$	$2.7X10^{-5}$	$1.0X10^{9}$	$2.7X10^{-2}$
Ta-178 (long-lived)	Tantalum (73)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ta-179		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ta-182		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Tb-157	Terbium (65)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Tb-158		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tb-160		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Tc-95m (a)	Technetium (43)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tc-96		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tc-96m (a)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Tc-97		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{8}$	$2.7X10^{-3}$
Tc-97m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Tc-98		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tc-99		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Tc-99m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Te-121	Tellurium (52)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Te-121m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Te-123m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Te-125m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Te-127		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Te-127m (a)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Te-129		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Te-129m (a)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Te-131m (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Te-132 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Th-227	Thorium (90)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Th-228 (a)		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Th-229		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Th-230		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Th-231		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Th-232		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Th-234 (a)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Th (nat)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Ti-44 (a)	Titanium (22)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Tl-200	Thallium (81)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tl-201		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tl-202		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tl-204		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{4}$	$2.7X10^{-7}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Tm-167	Thulium (69)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tm-170		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tm-171		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{8}$	$2.7X10^{-3}$
U-230 (fast lung absorption) (a)(d)	Uranium (92)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-230 (medium lung absorption) (a)(e)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-230 (slow lung absorption) (a)(f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-232 (fast lung absorption) (d)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
U-232 (medium lung absorption) (e)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-232 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-233 (fast lung absorption) (d)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-233 (medium lung absorption) (e)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-233 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-234 (fast lung absorption) (d)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$

Table A-2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides (Continued)

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
U-234 (medium lung absorption) (e)	Uranium (92) (Continued)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-234 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-235 (all lung absorption types) (a),(d),(e),(f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-236 (fast lung absorption) (d)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-236 (medium lung absorption) (e)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-236 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-238 (all lung absorption types) (d),(e),(f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U (nat)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
U (enriched to 20% or less)(g)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
U (dep)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
V-48	Vanadium (23)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
V-49		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
W-178 (a)	Tungsten (74)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
W-181		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
W-185		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
W-187		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
W-188 (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Xe-122 (a)	Xenon (54)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{9}$	$2.7X10^{-2}$
Xe-123		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{9}$	$2.7X10^{-2}$
Xe-127		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Xe-131m		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{4}$	$2.7X10^{-7}$
Xe-133		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{4}$	$2.7X10^{-7}$
Xe-135		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{10}$	$2.7X10^{-1}$
Y-87 (a)	Yttrium (39)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Y-88		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Y-90		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Y-91		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Y-91m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Y-92		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Y-93		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Yb-169	Ytterbium (79)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Yb-175		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Zn-65	Zinc (30)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Zn-69		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$
Zn-69m (a)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Zr-88	Zirconium (40)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Zr-93		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Zr-95 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Zr-97 (a)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$

NOTES

(a) A_1 and/or A_2 values include contributions from daughter nuclides w/half-lives less than 10 days.

(b) Parent nuclides and their progeny included in secular equilibrium are listed in the following:

Sr-90	Y-90
Zr-93	Nb-93m
Zr-97	Nb-97
Ru-106	Rh-106
Cs-137	Ba-137m
Ce-134	La-134
Ce-144	Pr-144
Ba-140	La-140
Bi-212	Tl-208 (0.36), Po-212 (0.64)
Pb-210	Bi-210, Po-210
Pb-212	Bi-212, Tl-208 (0.36), Po-212 (0.64)
Rn-220	Po-216
Rn-222	Po-218, Pb-214, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210

Ra-228	Ac-228
Th-226	Ra-222, Rn-218, Po-214
Th-228	Ra-224, Rn-220, Po-216, Pb212, Bi-212, Tl208 (0.36), Po-212 (0.64)
Th-229	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
Th-nat	Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-234	Pa-234m
U-230	Th-226, Ra-222, Rn-218, Po-214
U-232	Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
U-235	Th-231
U-238	Th-234, Pa-234m
U-nat	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214,
U-240	Np-240m
Np-237	Pa-233
Am-242m	Am-242
Am-243	Np-239

©) The quantity may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed distance from the source.

(d) These values apply only to compounds of uranium that take the chemical form of UF_6, UO_2F_2, and $UO_2(NO_3)_2$ in both normal and accident conditions of transport.

(e) These values apply only to compounds of uranium that take the chemical form of UO_3, UF_4, UCl_4, and hexavalent compounds in both normal and accident conditions of transport.

(f) These values apply to all compounds of uranium other than those specified in (d) and (e), above.

(g) These values apply to unirradiated uranium only.

APPENDIX B

APPENDIX B
Information Provided by Commenters

INTRODUCTION

This document was prepared in March 2003 and presents information provided by the commenters regarding the proposed rulemaking. The methodology is described below on page B-1. The information is organized into two issue outlines, one for quantitative and monetized information, and another for qualitative information. The quantitative and monetized information is provided from page B-1 to B-23 with qualitative information provided starting on page B-24. The list of commenters is presented beginning on page B-64.

METHODOLOGY

The comment letters were read and any information provided by the commenters was electronically copied into an issue outline. Information could include cost-benefit information, qualitative implications of the proposed rules, pertinent data, legal arguments, or other proffered information. The information was then separated into categories by content -- monetized, qualitative, or quantitative – within the issue outline. Qualitative information was then separated into a separate outline that is included after the outline of monetized and quantitative information. Information may be in more than one category within an issue and could also occur in more than one issue in the outline.

QUANTITATIVE AND MONETIZED

I. General Comments

Monetized

Commenter No. 1090-0049: [The ZEC wishes to emphasize that NRC's proposed rulemaking - without appropriate exemptions for natural materials and ores - would extend radioactive materials regulation to ores and natural materials having very low activity levels with resulting increased costs, transportation burdens and liabilities, all without justification.]

Quantitative

Commenter No. 1090-0039: [The exposure to the transport vehicle should not exceed 10 millirems/year. All crew compartments should be heavily shielded to reduce exposure.]

Commenter No. 1090-0041: [The established safety and performance record of transportation of radiopharmaceuticals to accommodate 14 million medical tests each year has demonstrated that existing controls are effective.]

Commenter No. 1090-0046: [At a time such as this, looking at the truly enormous increase in nuclear waste transportation that would be occurring if either the Yucca Mountain or Skull Valley project were to go forward, we really need to be strengthening our standards. There are millions of people, thousands of schools, and hundreds of hospitals residing directly along transportation routes.]

Commenter No. 1090-0008: [The United States Department of Transportation (DOT) and Nuclear Regulatory Commission (NRC) are proposing to weaken radioactive transport regulations at a time of potentially massive increases in nuclear waste shipments and the threats of deliberate terrorist attacks on shipments and use of radioactive materials for “dirty bombs.”]

Commenter No. 1090-0008: [Neither DOT nor NRC believes that the enormous expected increase in the number of shipments needs to be considered in making these changes that will inevitably affect those shipments and the thousands of communities through which they will pass in the decades to come. In fact they are satisfied to use twenty year old data to justify “updated” rule changes, some of which reduce public safety. We argue that the real world situation and updated data must be used to estimate the impacts of the rule change. DOT and NRC should use more current data and future projections including the expected increases in actual nuclear shipments.]

Furthermore, the frequency of plutonium shipments is expected to increase markedly in coming years for the reasons described above. Prudent regulatory philosophy mandates that, in anticipation of increased traffic and accident risks, the NRC should set the most conservative requirements, not lesser ones. [Commenter No. 1090 - 0128]

II. Issue-by-Issue Comments
- A. Issue 1 - Changing Part 71 to the International System of Units (SI) Only
  - i. Overall Impact (including cost-benefit data)
  - ii. NRC Proposed Position
- B. Issue 2 - Radionuclide Exemption Values
  - i. Overall Impact (including cost-benefit data)

Monetized

Commenter No. 1090-0052: [In the case of exemption values for fissile material the proposed rule is overly conservative and places increased costs and unnecessary burdens on the industry, specifically, in the case of bulk shipments of contaminated materials, such as soil or building rubble. Further the proposed rule for fissile exempt material is incompatible with the international standards and will complicate the international shipment of such materials.]

The Commission cites cost reduction as an incentive for the rule. However, the proposed rule is substantially more complicated can the existing rule and hence enforcement costs should rise, unless the Commission plans no enforcement. Moreover, although under standard economic theories, reducing economic costs of an activity should increase the frequency of the activity, the Commission simply states subjectively that it does not believe the activities affected by the rule will increase. It therefore appears that no substantive cost-benefit analysis has been performed. [Commenter No. 1090 - 0141]

Quantitative

Commenter No. 1090-0030: [NRC further indicates that a consequence of using the IAEA SS-115 and TS-R-1exemption values for transportation is that "the estimated average annual dose under the transportation scenarios exceeds the 10 mSv (1 mrem) per year criterion for some radionuclides." (67 FR 21396, April 30, 2002) The exceedance is not trivial; NRC staff finds that the average annual dose for a representative list of 20 radionuclides is 0.25 mSv *(*25 mrern) per year! *(Ibid.)* On the other hand, NRC staff also finds that "the corresponding dose for the current 70 Bq/g (0.002 mCi/g) exemption value, using the same transportation scenarios and radionuclides, is approximately 0.50 mSv *(*50 mrem) per year," i.e., about twice as high. *(Ibid.)*]

ii. Issue-Specific Discussion

Quantitative

Commenter No. 1090-0052: [The proposed exempt concentrations of Table A-2 appear to also result in a significant change in the requirements for the transportation of unimportant quantities of Source Material. The concentration of natural uranium in a material meeting the 0.05% limit of 10CFR40.13(a) is 355 pCi/g. This concentration exceeds the concentration limit of 270 pCi/g for Natural uranium in the proposed 71.14(a)(1). Similar examples are found for the exempt quantities given in 10CFR30.18. As a specific example, for Cs-137 the exempt quantity in Schedule B of 10CFR30 is 10 microCuries whereas the exempt consignment quantity limit of the proposed Table A-2 is 0.27 microCuries. Thus a quantity of Cs-137 that is exempt from licensing would have to be shipped as radioactive material under the proposed rules.]

iii. NRC Proposed Position

Quantitative

Commenter No. 1090-0038: [New § 71.14 (redesignated from current § 71.10) would modify the concentration levels below which radioactive substances are exempt from regulation during transportation. For many radionuclides, the revised exempt concentrations would be higher than the existing exempt concentrations (e.g., 14 times higher for plutonium-237; 14,000 times higher for tritium; 142,000 times higher for argon-39). These higher exempt concentrations would create a higher risk of harm from radiation exposure from a transportation accident and also create new and inadequately analyzed uncertainties about deregulated radioactive materials in commerce.]

Commenter No. 1090-0049: [As discussed at the June 24, 2002 public meeting, there are vast quantities of natural materials and ores of critical importance to the U.S. economy that are routinely transported in commerce. Many of these ores exceed 1 Bq/g uranium, and could become "radioactive" materials for transportation purposes if NRC fails to implement IAEA's exemption provisions. These materials include:

A. Phosphate ore and fertilizer. According to the U.S. Environmental Protection Agency ("EPA") *Diffuse NORM Wastes - Waste Characterization and Preliminary Risk Assessment(Draft)*(Contract No. 68-D20-155, April, 1993)(hereinafter, "EPA NORM Report"), phosphate ores range up to 10 Bq/g uranium. The U.S. Geological Survey ("USGS") reports that 32,800,000 metric tons of phosphate ore were mined in the United States in 2001. (See: U.S.G.S. Mineral Industry Surveys for Marketable Phosphate Rock, March 2002). EPA's NORM Report relates that "average" phosphate fertilizer contains 4.2 Bq/g uranium isotopes."

B. Zirconium ores. Zirconium ores in the form of zircon sand typically contain 2.5 to 3.5 Bq/g uranium and 0.5 to 1.0 Bq/g thorium, in equilibrium with decay progeny. U.S.G.S. reports that over 100,000 metric tons of zircon entered into commerce in 2001 *(Id.).*

C. Titanium minerals. The titanium minerals (ilmenite, leucoxene and rutile) are recognized to contain low, but measurable, concentrations of uranium and thorium, at up to 1 Bq/g. U.S.G.S. reports that 300,000 metric tons of titanium minerals were produced in the U.S. in 2001 (Id).

D. Tungsten ores and concentrates. Tungsten mineral ores and ore concentrates are known to contain naturally occurring uranium and thorium up to and, in some cases, exceeding 1 Bq/g concentration. Based on information reported by U.S.G.S, it is estimated that around 10,000 metric tons of tungsten ore entered into commerce in 2001 *(Id).*

E. Vanadium ores. Vanadium ores may contain up to several Bq/g uranium. U.S.G.S. reports 2001 U.S. consumption of vanadium was 3,600 metric tons.

F. Yttrium and rare earths. Rare earth minerals may contain several Bq/g uranium and thorium, with some exceeding “source material” levels of 10 C.F.R. Part 40. Data available from U.S.G.S. suggests that U.S. yttrium and rare earths ore production totaled less than 100 metric tons in 2001.

G. Bauxite and alumina. EPA's NORM Report identified 2.13 Bq/g total activity concentration for bauxite According to U.S.G.S., over 12,000,000 metric tons of bauxite and alumina were consumed in the U.S. in 2001.

H. Coal and coal fly ash. U.S.G.S, in *Radioactive Elements in Coal and Fly Ash: Abundance, Forms, and Environmental Significance* (Fact Sheet FS-163-97, October, 1997), reports that while U.S. coals contain 1 to 5 ppm uranium, the element becomes concentrated by at least an order of magnitude in coal fly ash. It is estimated that hundreds of millions of tons of coal fly ash are transported annually in the U.S.

From the above discussion, it can be seen that an immense quantity of mineral ores and products containing low levels of uranium and/or thorium are transported annually in commerce. Many of these materials exceed 1 Bq/g, and failure to implement IAEA’s exemption for natural materials and ores would dramatically expand the universe of materials regulated as “radioactive” for transportation purposes.]

Our opposition to petitioners request for relaxation of NRC's plutonium shipment containment requirements is based foremost on considerations of public health and future genetic integrity. These concerns are founded in the extreme toxicity of plutonium and its very long hazardous life. Pu-239, an alpha particle emitter, is a potent inducer of lung cancer. In addition to its hazardous life of at least 20 times the 24,400-year half-life, recent research indicates its assumed greater relative biological effectiveness may not adequately account for the potential microbiologic damage of alpha emitters. For this reason, instead of relaxation, "we strongly urge the NRC to set an even more rigorous packaging requirement for plutonium amounts below the 20 curies per package specified in 10 CFR 71.63. [Commenter No. 1090 - 0128]

Commenter No. 1090-0038: [*Doses to transportation workers and the general public during normal operations.* NRC has relied primarily on analyses done by the International Atomic

Energy Agency (IAEA) which showed that the average annual modeled dose of this type, based on 20 representative radionuclides, was about 0.50 mSv (50 mrem) for the current exemption values in 10 CFR Part 71 and about 0.25 mSv (25 mrem) for the proposed revision of the exemption values. (67 FR 21396, April 30,2002) Although the proposed revision cuts the average modeled dose in half; the dose is still much too high. One of IAEA's own exemption criteria is that the effective annual dose to a member of the public from a radioactive source or practice should be unlikely to exceed 10 mSv (1 mrem). (*Ibid)* Thus, the average modeled dose would still exceed IAEA's exemption criterion by a factor of 25. If a major regulatory revision is being carried out, thereby offering an opportunity to remedy an existing section of 10 CFR Part 71 that allowed a 5O-fold exceedance of a recommended dose, then the major regulatory revision should ensure a 50-fold dose reduction. In this case, the 2-fold dose reduction offered by the proposed revision is grossly inadequate.]

Commenter No. 1090-0049: [Note that some nuclides listed in Table I have a reference to footnote (b). These nuclides have the radiological contributions from their daughter products (progeny) already included in the listed value. For example, natural uranium [U(nat)] in Table I has a listed activity concentration for exempt material of 1 Bq/g (2.7x 10-5 uCi/g). This means the activity concentration of the uranium is limited to 1 Bq/g (2.7 x 10-5 uCi/g), but the total activity concentration of an exempt material containing 1 Bq/g 92.7 x 10-5 uCi/g) of uranium will be higher (approximately 7 Bq/g (1.9 x 10-4 uCi/g)) due to the radioactivity of the daughter products.]

The Commission’s further summary of the IAEA standards indicated that the IAEA has not established limits that would successfully enforce that principle. The Commission estimates (based on an examination of only 20 of the over 350 isotopes involved in the rule-making) that the proposed exemption values lead to an average annual individual transportation dose of 25 mrem per radionuclide. It is unclear why such calculations were performed for only 20 of the over 350 isotopes involved in the proposed regulation. If the estimated dose from each radionuclide is approximately the same, then the Commission ought at minimum to reduce an exemptions by a factor of at least. If the estimated doses vary significantly with radionuclide, then the Commission ought to withdraw the rule completely and begin anew, performing more accurate and complete calculations. Further review of the proposed rule suggests that withdrawal is the most appropriate course. First, the exact significance of “per radionuclide” here is unclear. By its use of this phrase, the Commission appears to allow annual individual doses somewhere between (25)(20) = 500 mrem and (25)(350) = 8750 mrem for the transportation scenario, and doses in this range may not be negligible. Second, it also seems likely that other exposure scenarios would lead to annual individual doses rather exceeding the estimated individual doses expected from transportation alone. Third, it is unclear whether the comparisons, based on only 20 isotopes, of the current 70 bq/g exemption limits with the proposed limits, are meaningful. [Commenter No. 1090 - 0141]

If the Commission has already collected the data necessary to model accurately the impacts of the proposed regulation, then modeling all affected isotopes should not have required substantially more time than modeling the rule for 20 isotopes, because initial programming generally represents the greater majority of the labor involved in repetitive or routine calculation, when using high Speed computing devices. This suggests that the Commission has not collected the data necessary to model with all affected isotopes, hence that the Commission cannot have adequate basis for the proposed rule-making. Unless complete modeling were done, it is unclear how the Commission could obtain its precise “average” doses of 25 mrem/yr and 50 mrem/yr per radionuclide under the proposed and existing regulatory regimes for the 20 isotopes for which transportation calculations were performed. Expected exposures will vary, depending on the actual amounts of the individual isotopes actually shipped, and therefore a weighted average, based on the expected distribution of the isotopes shipped, would be more appropriate. Such weighted averages are needed for meaningful comparison of expected dose under the existing and proposed regulatory regimes. If the Commission simply studied the 20 isotopes individually and then calculated an unweighted average of the 20 resulting expected annual doses, then the calculation is meaningless and provides no adequate basis for regulatory change. Moreover, the Commission seems not to have obtained substantive distribution and quantity information for isotope shipments. The proposed rule-making should he postponed until the Commission obtains this information and accurately models the effect of the proposed rule, taking in account the amounts of all 350+ individual isotopes actually shipped. [Commenter No. 1090 - 0141]

C. Issue 3 - Revision of A_1 and A_2

Quantitative

Commenter No. 1090-0052: [The entry for specific activity of U(dep) in SI units is incorrect. This entry should reference footnote (2).]

i. Overall Impact (including cost-benefit data)
ii. Issue-Specific Discussion
iii. NRC Proposed Position

Quantitative

Commenter No. 001: [Radionuclide Al-26 value for specific activity in 10 CFR 71 Table A-1 should be changed from 190 Ci/g to 0.019 Ci/g.]

Commenter No. 001: [A_1 and A_2 values in both 10 CFR 71 Table A-1 and 49 CFR 173.435 for Ar-39 appear reversed from that listed in IAEA TS-R-1.]

Commenter No. 001: [Radionuclide Be-10 value for specific activity in 10 CFR 71 Table A-1 should be changed from 220 Ci/g to 0.022 Ci/g.]

[Radionuclide Cs-136 value for specific activity in 49 CFR 173.435 should be changed from 0.0027 TBq/g to 270 TBq/g.]

[Radionuclide Dy-165 value for A_2 (Ci) in 10 CFR 71 Table A-1 should be changed from 0.16 to 16 Ci.]

[Radionuclide Eu-150 (long-lived) value for A_1 (TBq) in 10 CFR 71 Table A-1 and 49 CFR 173.435 is not consistent with IAEA TS-R-1 value of 0.7.]

[Radionuclide Fe-59 value for A_2 (TBq) in 10 CFR 71 Table A-1 is in error.]

[Radionuclide Ho-166m value for A_2 (TBq) in 10 CFR 71 Table A-1 should be 0.5.]

[Radionuclide K-43 value for A_2 (TBq) in 10 CFR 71 Table A-1 should be 0.6.]

[Radionuclide Kr-81 value for A_1 (TBq) in 49 CFR 173.435 should be 40, A_1 (Ci) in 49 CFR 173.435 should be 1100.]

[Radionuclide Kr-85 value for A_2 (TBq) in 49 CFR 173.435 should be 10, A_2 (Ci) in 49 CFR 173.435 should be 270.]

[Radionuclide La-140 value for A_2 (Ci) in 49 CFR 173.435 should be 11.]

[Radionuclide Lu-177 value for A_2 (TBq) in 49 CFR 173.435 should be 0.7, A_2 (Ci) in 49 CFR 173.435 should be 19.]

[Radionuclide Mn-52 value for specific activity (Ci) in 49 CFR 173.435 should be 4.4E+05.]

[Radionuclide Np-236 (long-lived) value for A_1 (TBq) in IAEA TS-R-1 is 9; A_2 (TBq) in IAEA TS-R-1 is 0.02, different from the valudes in both 49 CFR 173.435 and 10 CFR 71, Table A-1.]

[Radionuclide Pt-197m value for A_2 (TBq) in 49 CFR 173.435 should be 0.6, A_2 (Ci) in 49 CFR 173.435 should be 16.]

[Radionuclide Pu-239 value for A_2 (Ci) in 10 CFR 71, Table A-1, should be 0.027.]

[Radionuclide Pu-240 value for specific activity (Ci) should be 0.23 Ci/g.]

[Radionuclide Ra-225 value for A_2 (Ci) in 10 CFR 71, Table A-1, should be 0.11.]

[Radionuclide Ra-228 value for A_2 (TBq) in 10 CFR 71, Table A-1, should be 0.02.]

[Radionuclide Rh-105 value for A_2 (Ci) in 10 CFR 71, Table A-1, is in error.]

[Radionuclide Sc-46 value for A_1 (TBq) in 10 CFR 71, Table A-1, should be 0.5.]

[Radionuclide Sn-119m value for A_2 (TBq) in 10 CFR 71, Table A-1, should be 30.]

[Radionuclide Sn-126 value for specific activity (TBq) in 10 CFR 71, Table A-1 should be 0.001.]

[Radionuclide H-3 value for A_2 (TBq) in 10 CFR 71, Table A-1, should be 40.]

[Radionuclide Ta-179 value for A_1 (TBq) in 10 CFR 71, Table A-1, should be 30.]

[Radionuclide Tb-157 value for A_1 (TBq) in 10 CFR 71, Table A-1, should be 40; value for specific activity (TBq) in 10 CFR 71, Table A-1, should be 0.56 TBq/g.]

[Radionuclide Tb-158 value for A_2 (Ci) in 10 CFR 71, Table A-1, should be 27, value for specific activity (TBq) in 10 CFR 71, Table A-1, should be 0.56 TBq/g.]

[Radionuclide Tb-160 value for A_1 (Ci) in 10 CFR 71, Table A-1, should be 27.]

[Radionuclide Tc-96 value for A_1 (TBq) in 10 CFR 71, Table A-1, should be 0.4.]

[Radionuclide Tb-96m value for A_1 (TBq) in 10 CFR 71, Table A-1, should be 0.4, value for A_2 (TBq) in 10 CFR 71, Table A-1, should be 0.4.]
[Radionuclide Tc-97 value for specific activity (TBq) in 10 CFR 71, Table A-1, should be 5.2E-05, value for specific activity in 10 CFR 71, Table A-1, should be 0.0014.]

[Radionuclide Te-125m value for A_2 (Ci) in 10 CFR 71, Table A-1, should be 24.]

[Radionuclide Te-129 value for A_1 (TBq) in 10 CFR 71, Table A-1, should be 0.7, value for A_2 (TBq) in 10 CFR 71, Table A-1, should be 0.6.]

[Radionuclide Te-132 value for A_1 (TBq) in 10 CFR 71, Table A-1, should be 0.5.]

[Radionuclide Th-227 value for A_2 (Ci) in 10 CFR 71, Table A-1, should be 0.14.]

[Radionuclide Th-231 value for A_2 (TBq) in 10 CFR 71, Table A-1, should be 0.02.]

[Radionuclide Th-234 value for A_1 (TBq) in 10 CFR 71, Table A-1, should be 0.3.]

[Radionuclide Ti-44 value for A_1 (TBq) in 10 CFR 71, Table A-1, should be 0.5, value for A_2 (TBq) in 10 CFR 71, Table A-1, should be 0.4, value for A_2 (Ci) in 10 CFR 71, Table A-1, should be 10.]

[Radionuclide Tl-200 value for A_1 (TBq) in 10 CFR 71, Table A-1, should be 0.9.]

[Radionuclide Tl-204 value for A_2 (TBq) in 10 CFR 71, Table A-1, should be 0.7.]

[Radionuclide U-230, U-232, U-233, and U-234 values for medium and slow lung absorption, and U-236 values for slow lung absorption are not consistent with IAEA TS-R-1.]

Commenter No. 1090-0043: [The proposed shipments of radioactive wastes to a repository should not be the occasion for a reduction in the standards of radiation protection during transportation. On the contrary, the possibility of 90,000+ shipments calls for an increased radiation protection standard. We oppose the weakening of the present standard.]

Revision of A-1 and A-2: At 21399, staff states that new A-1 and A-2 values are "in general" increased "'within a factor of about three of the earlier values." This indicates, for the radionuclides with higher values, a significant amount of increase in allowable exposures to members of the public, absent increased benefit to the recipients. Increased values should not he adopted. From the NRC's narrative, it appears that these increases are proposed only to conform with IAEA values. That is not a valid justification for any increased levels of exposure for American citizens. Again, negative impacts on the nuclear industry are not justifiable reasons for NRC to relax any standards for protection of the public. [Commenter No. 1090 - 0128]

Commenter No. 1090-0044: [In trying to understand the derivation of the discrete levels of radionuclides in the amended Part 71, I looked at those nuclides that I believe are listed in Table A-1 as being allowed to be shipped in “unlimited" amounts of terabecquerels or curies. I thought perhaps they were chosen because most of them have very long half-lives---such as, samarium-147 (106 billion years), thorium-232 (14.1 billion years), and rubidium-87 (47.5 million years**).** But zirconium-88 is also included, with only an 83 .4-day half-life, while zirconium-96 is not. The Zr-96 half-life is more than 20,000,000,000,000,000,000 years. (CRC Handbook of Chernistrv and Physics, 82nd Edition, 2001-2002; p. 11-82.)]

D. Issue 4 - Uranium Hexafluoride UF_6 Package Requirements

i. Overall Impact (including cost-benefit data)

Monetized

Commenter No. 1090-0052: [Higher enrichments are always being considered in the industry and there are high costs of greater than 5% enrichment associated with plant modifications and licensing. However, it may not be viable if the transport costs were so high because of the requirement to have special packages, over-packs, increased handling and the very small quantities that could be shipped at one time. There will also be plant interface problems with different shipping packages for different enrichments.]

ii. Issue-Specific Discussion

Quantitative

USEC believes that the current practice of excluding moderators in criticality evaluations for UF6 packages should be continued. The justification for excluding moderators has not changed and the nearly 50 years of safe shipping (USEC typically ships several thousand UF6 cylinders a year), with no accidents in the USA resulting in a release of UF6, indicates that the current practice is adequate to assure safe shipments. [Commenter No. 1090 - 0054]

iii. NRC Proposed Position

Monetized

Commenter No. 1090-0053: [*Industry Position:* Industry supports the NRC position, but with the following caveat. As drafted, the proposed § 71.55(g) would restrict a UF_6 package contents to a maximum enrichment level of 5% ^{235}U. This is problematic, as the NRC would be codifying an enrichment level that will likely be exceeded in fuels for new generation reactors or for higher burn-up levels. For higher enrichments, any UF_6 packages would, therefore, need to meet the requirements of § 71.55(b). This would likely necessitate fairy significant changes to (and costs for) the type of UF_8 packages currently used by the industry.]

Quantitative

Commenter No. 1090-0007: [CHT understands that the Proposed Rulemaking may codify a limitation on the enrichment of UF_6 at no more than 5wt% of U-235. CHT submits that the industry is seriously considering and moving towards the use of enrichments greater than 5wt %, to achieve more efficient operation of the fuel assemblies. In addition, the Pebble Bed reactor would require enrichments greater than 5wt% of U-235.

CHT requests that the final 10 CFR 71 regulations stipulate that enrichments of UF_6 be limited to 5wt% U-235 for the standard ANSI N14.I 30B cylinder, but further allow for special design features of an alternative cylinder and protective shipping package that clearly demonstrates the ability to remain sub critical at stipulated enrichment levels up to a maximum of 10 wt% U-235, in addition to all other provisions of 10 CFR 71. CHT submits that certain design features such as (i.) moderation control devices, (ii.) mass control (decrease) of the UF6, and (iii.) cylinder geometry control could allow for enrichments greater than 5wt % U-235. In the opinion of CHT, the foregoing special design features embodied in an alternative UF_6 cylinder could be utilized in the presently approved protective shipping packages. The economic cost of special design features of an alternative UF_6 cylinder are minimal, as compared to the cost of new protective shipping packages. In summary, CHT requests a special provision for an improved UF_6 package with special designs features for enrichments greater than 5wt% U-235, but retain the limitation 5wt% U-235 with respect to the existing ANSI N14.1 Model 30B cylinder.]

UF-6 Package Requirements: No relaxation of packaging standards should be allowed. In recent months, the United States has experienced both prolonged fire (Baltimore tunnel hazardous waste accident) and higher drop with extended submersion (Arkansas River bridge rammed and collapsed by a barge, caused by human error) exceeding current container test requirements. NO exemptions from requirements should be allowed. [Commenter No. 1090 - 0128]

E. Issue 5 - Introduction of the Criticality Safety Index Requirements

i. Overall Impact (including cost-benefit data)
ii. Issue-Specific Discussion
iii. NRC Proposed Position

Monetized

Commenter No. 1090-0053: [*NRC requests information:* What cost or benefit impacts would result if the per package Criticality Safety Index (CSI) were to change from 10 to 50?

Industry Response: The increase of the CSI from 10 to 50 would have a major detrimental impact in shipping and intermodal storage areas. This could increase the number of shipments to avoid the staging of the packages at a storage facility incident to transport. The NRC is proposing changes to Part 71 that would dramatically impact international transports of fissile material. § 71.22(d)(3) and § 71.59©)(1) would limit the sum of the CSIs to less than or equal to 50 when the material is stored incident to transport. This would mean that a shipment resting at a port after being unloaded from an ocean vessel and awaiting loading on a truck for onward shipment would be limited to a combined CSI of 50. As noted earlier, this change would effectively remove the exclusive use authorization for multi-modal shipments. Cost increases would be incurred in the documentation and scheduling areas. It would also increase the cost in customs handling and applications for import or export. It would increase the actual shipping cost, as higher rates would be charged due to smaller shipments. Demurrage fees would increase as less than fully loaded seapacks would be employed. Specific numbers are hard to identify, but it is clear this change would have a major detriment to shipping costs.]

Quantitative

Commenter No. 1090-0053: [*Industry Position:* Industry supports the NRC position to add a CSI to 10 CFR 71. However, adoption of a CSI and the 50 limit will dramatically impact international transports of fissile material. § 71 .22(d)(3) and § 71 .59(c)(l) would limit the sum of the CSIs to less than or equal to 50 when the material is stored incident to transport. This would mean that a shipment resting at a port after being unloaded from an ocean vessel and awaiting loading on a truck for onward shipment would be limited to a combined CSI = 50. This change would effectively remove the exclusive use authorization for multi-modal shipments.

NRC's proposed changes to § 71.59(b) and ©) constitute an overly conservative application of the CSI. The CSI is determined by dividing 50 by “N,” where “N” refers to the number of packages used in the 5N/2N-criticality safety array size demonstration of safety. In this demonstration “N” already represents a safe and acceptable array of packages and establishes an appropriate safety limit. The CSI is appropriate for use in demonstrating safety, but it should not be used in a manner that would further limit the array size of packages, overpacks or freight containers.

The proposed revision of § 71.59(b) includes the sentence: Any CSI greater than zero must be rounded up to the first decimal place." As TS- R-1 does not require such rounding, the proposed § 71.59(b) is inconsistent with the IAEA guidance and the rounding-up requirement should be deleted. The requirement to round-up the CSI value, in effect, places additional limits on the array size and further limits shipments unnecessarily. For example, for the case in which the 2N value for a package equals 150 (N=75) as the limiting safety case, the CSI equals 0.6666. An array of packages would have a total CSI value of 50. If the CSI were rounded-up to the nearest tenth, then 75 packages would have a total CSI of 52.5 and the array would have to be limited to 71 packages to keep the CSI value equal to 50. This rounding-up causes an unnecessary 5% reduction in number of packages required to ship a given quantity of material. It unnecessarily increases the number of shipments required without any improvement in safety.]

In 71.59 (b) proposed, the sentence "Any CSI greater than zero must be rounded up to the first decimal place." must be eliminated. This rounding requirement is inconsistent with TS-R-1, which does not require rounding. In addition by requiring rounding-up, this requirement in effect places additional limits on the array size and unnecessarily further limits shipments. For example, in a case where the 2N value for a package = 150 (N=75) is the limiting safety cast for non-excusive use is then 50 / 75=0.6666. In this case, an array of packages would have a total CSI value of <50.

Using the rounded CSI result, the maximum allowable number of packages per non-exclusive use 50 / 0.7 = 71. Thus, if the CSI were rounded-up to the nearest tenth, the previously derived N =75 packages would now have an arbitrarily (revised) CSI corresponding to 52.5, and the array would have to be limited to 71 packages to remain equal to 50. This is an unnecessary 5% reduction in number of packages to ship a given quantity of material and therefore unnecessarily increases the number of shipments required without any improvement in safety. [Commenter No. 1090 - 0143]

USEC supports adoption of the CSI but opposes the proposed text in 10 CFR 71.59(c)(l) that would limit the CSI to 50 for accumulated fissile materials while in storage incident to transport. This limit would dramatically impact the "Megatons to Megawatts" program—a government-to-government nuclear non-proliferration program that imports low enriched uranium derived (DEU) from dismantled weapons of the former Soviet Union. Typically, approximately 30 of the DEU packages arc transported on a ship from Russia to a port in the USA before being shipped by truck to USEC's gaseous diffusion plant. If the CSI for in-transit storage were limited to 50, the port could store only ten of the DEU packages (each with an assigned CSI of 5) while they were awaiting transfer to the trucks. The remaining 20 DEU cylinders would have to be left aboard the ship until the first cylinders were cleared by Customs—a process that typically takes several days—and removed from port storage. The ensuing bottleneck would create logistical, cost and risk impacts for no apparent safety benefit Indeed, the need to delay the departure of the ship to accommodate USEC could lead the shipping line to decide to refuse to carry USEC's cargo. Alternatively, if USEC shipped only 10 packages per vessel to meet the ten packages per in-transit storage CSI limit, the number of shipments would have to increase by a factor of three, with an associated increase in cost and risk. Even if increasing the number of shipments were desirable, however, it would be impossible because there are not enough vessels available for shipping radioactive materials to support the large number of shipments that the Megatons-to-Megawatts program would need. [Commenter No. 1090 - 0054]

F. Issue 6 - Type C Packages and Low Dispersible Material
  i. Overall Impact (including cost-benefit data)
  ii. Issue-Specific Discussion
  iii. NRC Proposed Position

G. Issue 7 - Deep Immersion Test
  i. Overall Impact (including cost-benefit data)
  ii. NRC Proposed Position

Quantitative

Deep immersion Test Requirements should be markedly upgraded. A one-hour submersion without collapse, buckling, or leakage is wholly inadequate as a risk basis, given that as many as 100,000 shipments of highly irradiated "spent" fuel are anticipated to be moving transcontinentally on highways and railroads - even more will have to go somewhere if the NRC continues to pursue the granting of 20-year license extensions for aging reactors and if the NRC persists in its plans for licensing new reactors. Barge shipments should be prohibited outright. Highly irradiated "spent" fuel does not belong on our lakes, rivers, or offshore. The Commission will be remiss if it fails to toughen immersion testing for shipping canisters. [Commenter No. 1090-0128]

H. Issue 8 - Grandfathering Previously Approved Packages

  i. Overall Impact (including cost-benefit data)
  ii. Issue-Specific Discussion

Monetized

Commenter No. 1090-0053: [*NRC Request for Information:* Under what conditions should packagings be removed from service?

Industry Response: Packages should be removed from service if they cannot meet the safety requirements to which they were designed or if new safety issues are recognized that would prevent the package from meeting its safety function. Packages should remain in service indefinitely unless either of the above two conditions were to exist. Industry does support the phase-out of older packages by not manufacturing new packages to the old specifications; however, packages currently in use should be allowed to continue in use. The industry currently projects that it will cost approximately $500,000 to re-certify a 1967 package. We have identified five packages in this category: therefore, the re-certification case is a minimum of $2,500,000. In lieu of re-certification it would cost about the same for the certification of a new design, following the design work plus the cost to manufacture the replacement packages. Therefore, the replacement design cost would be $2,500,000 for certification plus about $2,500,000 for the design work and $10,000,000 for the manufacture of the replacement packages. These cost estimates are based on the family of the five known packages. We have reason to believe that there are additional packages in use by small companies that have not been tracking the potential changes and impacts.]

Commenter No. 1090-0053: [*NRC Request for Information:* What are the cost or benefit impacts associated with the proposal to remove B( ) packages from service?

Industry Response: Accurate data are not currently available to forecast cost-benefit impacts. There are only a few B( ) packages in use. The NRC needs to work with each holder of B( ) packages to determine if they wish to maintain this package.]

iii. NRC Proposed Position

Monetized

Commenter No. 1090-0042: [There are some 1000 devices manufactured by JLS&A, and shipped in either NRC COC or DOT Specification containers built to the 1967 standards, in current use throughout the United States. It is certain that under the proposed regulations JLS&A would have to obtain at least two COCs (one relating to COC 6280, the other to DOT Specification 20WC containers), either to requalify existing containers or to construct new ones meeting the TS-R-I requirements. It is possible that JLS&A would have to obtain as many as a dozen or so COCs, depending on the NRC's licensing flexibility.[24] The elements of compliance

[24] JLS&A's devices are not totally identical: they come in various models designed for customer-specific needs, which vary somewhat in size, dimensions and weight. However, there are two principal model "families", one designed for NRC COC containers and one designed for DOT Specification containers. JLS&A has two virtually identical outer containers manufactured under NRC COC 6280 in active service. It has also about 15 slightly smaller containers, similar but not identical to each other, manufactured to DOT Specification 20WC, in service. The NRC COC containers are intended for shipment of devices in one model "family", without being designed uniquely for specific devices within that "family." The same applies to the DOT Specification containers and devices within the other model "family." Thus, depending on the degree of flexibility granted by the NRC in licensing of new containers

for JLS&A can be itemized as follows:

- It will cost at least $500,000[25] and take upwards of two years[26] to design, test and obtain regulatory approval for a new <u>or</u> <u>requalified</u> COC from the NRC. Thus the cost of redesign/reapproval would range between $1 million and $6 million for JLS&A, depending on the number of new COCs JLS&A would be required to obtain.

- JLS&A would also have to construct new overpacks to meet the parameters of each new COC.[27] Each one of these would cost about $50,000. Anticipated additional costs here to JLS&A range between $600,000 and $750,000.

- The value of existing overpacks, with a per-unit depreciated value of about $30,000 apiece, would be lost. For JLS&A, this cost component would be approximately $500,000.

Thus the overall cost of compliance for JLS&A would be, at the low end, slightly more than $2 million, and at the upper end, on the order of $8 million. These costs are incurred even if it is assumed that all existing devices will be able to be shipped legally in existing, requalified containers or new COC containers.

JLS&A is a firm with annual revenues and a total net worth in the mid-seven digits. Having to spend approximately one year's total revenues or its total net worth, or several times annual profits, on a short-order backfit that increases neither productivity, profitability nor safety, would be a sufficiently questionable economic decision that the company would, instead, regretfully, probably close its doors and go out of business.]

Commenter No. 1090-0042: [Even if existing JLS&A devices can be legally shipped, JLS&A will need to attempt to pass on its increased costs to its customers. If JLS&A devices cannot be legally shipped, however, customers' costs rise substantially. In that event, the value of these devices is largely or totally lost from the time they need to be re-sourced or refurbished. At an average cost of approximately $50,000 per unit, this means an aggregate cost on the order of $50 million, distributed among several hundred JLS&A customers. This is a realistic scenario:

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or requalification of existing ones, JLS&A would have to obtain anywhere between two and about a dozen new COCs, in order to account for the variations between different device models.

[25] Costs are distributed among engineering and design costs ($l00,000-$150,000), fabrication of one or more test prototypes ($50,000 apiece), testing and analysis ($100,000-$150,000) and NRC licensing fees and related costs ($120,000-$200,000).

[26] In the interest of simplicity, the factor of time will not be considered in this evaluation. Obviously, if the NRC finds itself with a large backlog of COC applications, the time required to approve them will increase.

[27] It is possible that outer containers already licensed to 1967 standards under an existing NRC COC could be requalified under the new criteria. However, because of historic differences between NRC and DOT requirements, particularly QA paperwork requirements, it seems unlikely that any DOT-Specification containers built to 1967 standards could ever be certified by the NRC unless the NRC interprets the documentation requirements of Part 71 Subpart H flexibly. Thus all DOT-Specification containers would, in all likelihood, have to be replaced.

On those devices which were built to be shipped in DOT-Specification outer containers, the inner containers were built under Quality Assurance standards that were not governed by the NRC's QA program in 10 CFR Part 71, §§ 71.101-71.135. As a result, the documentation or "QA Paper" for these devices may not conform to NRC QA requirements even though actual design, procurement and construction standards may have been identical or equivalent to NRC standards. Thus is would not be possible to document the "pedigree" of such components as the shielding and the housing of these devices, which are integral to the device but technically part of the "packaging" as defined in NRC and DOT regulations (10 CFR § 71.4.49 CER § 173.403)). Unless the NRC either amends or relaxes its interpretation of its QA requirements, it appears likely that it will not accept packages initially designed and manufactured to DOT specifications. In that event, the cost of compliance would rise dramatically, as one of three scenarios would follow:

1. Transportation containers would have to be designed[28] that could transport existing devices - which weigh up to 5000 pounds for a model 7A designed to be transported in a 20WC-6 container - without taking any credit for the radioactive shielding or structural housing surrounding the source. Such containers would weigh, in all probability, upwards of 60,000 pounds, thus requiring special highway authorizations and being subject to limited routings; would need a dedicated tractor and a specially designed trailer to transport them; and would be enormously expensive to build - several times the cost of a container that could take credit for the structural properties of the inner container. It is estimated that designing, licensing and constructing such a container, with dedicated tractor and specially designed trailer, would cost upwards of $2,250,000. The cost of succeeding containers, each with its own trailer, would approach $1,000,000 apiece. Shipping costs for these containers would also be an order of magnitude higher than those for current devices ($35,000-$40,000 v. $3000 per trip now for a 20WC). Even then, the transportation rig would be unable to access numerous locations that can now be reached, thus running the risk that some sources would remain stranded no matter what. Thus this alternative, while technically feasible, is physically cumbersome and sufficiently more costly than current shipping modes that many existing customers would be tempted to buy and ship new devices rather than have existing ones re-sources or hauled away for decommissioning.

2. Sources could be transferred at the customer's site from the existing device to a specially designed "transportation container," using a portable hot cell transported to the customer's site. JLS&A has not fully costed out this alternative because it appears to have almost insuperable obstacles. First, most of JLS&A's devices are fabricated with welded end-caps, in order to prevent tampering by unauthorized persons. As a result, removing the source is a difficult, potentially high-exposure process when conducted in the field. Second, setting up a hot cell is an unavoidably expensive business - on the order of $300,000 per installation. Even if devices were designed with screw-on end

[28] To the best of JLS&A's knowledge, based on a review of the SS&D Registry within the past year, there is no existing licensed transportation container that can be used to transport all, or even a majority, of its sources in their 7A shipping configuration, giving no credit for their shielding. Such existing containers as can transport even some of JLS&A's devices in this fashion are typically used for transporting radioactive waste, and thus are sufficiently contaminated that their use for transporting laboratory equipment, which has been manufactured in a clean room and kept rigorously free of stray radiation, would be highly questionable.

caps (and some of JLS&A's, though a minority, are) and special shipping containers were designed to operate with them - thus substantially lessening the labor and radioactive exposure associated with a transfer -it would still be necessary to set up a portable hot cell. This alternative is prohibitively expensive except in extreme conditions. It is also inconsistent with the ALARA goal of minimizing occupational exposures to radiation.

3. Existing sources in existing devices manufactured to DOT specifications would become unshippable in existing packages, and their value would be lost as of the time their sources next need to be removed. JLS&A has nearly 1000 of these devices in service throughout the US, so the cost to JLS&A's customers, at an avenge value of $50,000, would be $50 million. JLS&A regards this scenario as the most likely, since the cost of the other two scenarios is likely to deter market entrants.]

Commenter No. 1090-0042: [As noted above, JLS&A is not aware of published data that describe the total number of 1967-Specification containers (DOT- or NRC-approved) in use today in the U.S., or the number of device designs, or the number of actual devices affected by the proposed rule. However, JLS&A believes that the total numbers are on the order of 10 to 15 times its own. In that event, the economic costs projected by JLS&A for itself can be extrapolated as follows:
- costs of design, testing and licensing of new designs: $10,000,000 to $90,000,000
- costs of construction of new overpacks: $6,250,000 to $12,500,000
- loss of value of existing overpacks: $5,000,000 to $10,000,000
- loss of value of existing devices: $500,000,000 to $1,000,000,000.

These are only estimates based on extrapolations, not on real data. Nonetheless, they are based on real knowledge of the industry and make clear that the projection in both NRC'S and DOT'S rulemaking notices, and of the NRC's draft Regulatory Analysis that they do not expect any significant costs to be associated with the implementation of the rule, is wrong.]

Commenter No. 1090-0053: [One company has two NRC CoC containers and about a dozen DOT-specification containers, all built to the 1967 specifications that are used to make a couple of hundred shipments of Type B materials per year, mostly within the US. Were use of 1967-specification containers phased out, this company will either have to requalify all of its containers or leave the business. This would necessitate requalification for two CoCs (the current CoC and one for its DOT-specification containers). As the requalification costs approach $500,000 per CoC, having to do so would be punitive, if not ruinous, to them (their annual revenues are on the order of $5M/yr) even in this “best case” scenario.]

Commenter No. 1090-0053: [The cost of replacing these transport containers with ones meeting the proposed regulations, and having these packages reviewed and accepted by the NRC, is estimated at over a million dollars. Cost aside, however, it is unlikely that the NRC would approve any new containers before the implementation date. Therefore adoption of the new regulations will eliminate our Company’s ability to provide a domestic supply of critical radioisotope for both U.S. commercial and military applications and will dictate that only foreign Companies import this material.]

Quantitative

Commenter No. 1090-0042: [The significant majority of JLS&A's business is totally internal to the United States. Currently in the United States there are about 1000 devices designed and manufactured by JLS&A for shipment in 1967 Specification containers, pursuant to either an NRC COC or to DOT Specification 20WC. These devices are found at every nuclear power plant in the country, in universities, hospitals and blood banks, and in other private, government and military research facilities. Depending on the year, between 65% and 85% of JLS&A's shipments are for the benefit of taxpayer-funded sources, meaning that any substantial increase in the cost of shipment of these devices will affect programs as diverse as medicare, medical research, defense and homeland security spending.]

Commenter No. 1090-0042: [Use of 1967 Specification packages remains widespread. JLS&A itself has shipped over 1000 irradiators and calibrators to customers throughout the United States using such packages. Most of these devices have been shipped in packages designed and manufactured pursuant to DOT Specification 20WC. A smaller number have been shipped in packages approved by the NRC under COC 6280. Most of the units ever shipped are still in use. All of these devices need to be periodically re-sourced and refurbished; some occasionally need to be relocated; all eventually need to he removed from service, or decommissioned. JLS&A typically makes close to 200 shipment legs per year for such operations.[29] JLS&A does not own any other overpacks suitable for shipping these devices.

It is not possible to tell from published information exactly many companies routinely use 1967-Specification packages to ship devices or other radioactive sources, or how many such devices and other sources there are.[30] However, JLS&A believes that several other firms in the private sector depend on them to a similar degree as it does; and believes that the U.S. Department of Energy makes widespread use of them for both its Civilian Reactor Waste and Naval Nuclear programs. Based on general industry knowledge, JLS&A believes that there are between 100 and 200 20WC Specification containers in use in the United States today, in addition to the 15 owned and used by JLS&A. On the same basis, JLS&A believes that there are probably between 25 and 50 active 1967 Specification COC containers in service, in addition to the two it owns. If these estimates are accurate, the overall effect of implementation of the proposal to eliminate use of 1967 Specification packages will be on the order of 10 to 15 times that projected by JLS&A for itself.]

Commenter No. 1090-0042: [There are some 1000 devices manufactured by JLS&A, and shipped in either NRC COC or DOT Specification containers built to the 1967 standards, in current use throughout the United States. It is certain that under the proposed regulations JLS&A would have to obtain at least two COCs (one relating to COC 6280, the other to DOT Specification 20WC containers), either to requalify existing containers or to construct new ones meeting the TS-R-I requirements. It is possible that JLS&A would have to obtain as many as a

[29] Over half, but not all, of these shipment legs, involve loaded containers. Each complete shipment involves at least two legs.

[30] The SS&D Registry, NUREG-0383, lists active and inactive products for active and inactive vendors, but does not indicate either how many such products have actually been manufactured or how many packages have been made to transport these products, for use with each certificate.

dozen or so COCs, depending on the NRC's licensing flexibility.[31] The elements of compliance for JLS&A can be itemized as follows:

- It will cost at least $500,000[32] and take upwards of two years[33] to design, test and obtain regulatory approval for a new or requalified COC from the NRC. Thus the cost of redesign/reapproval would range between $1 million and $6 million for JLS&A, depending on the number of new COCs JLS&A would be required to obtain.

- JLS&A would also have to construct new overpacks to meet the parameters of each new COC.[34] Each one of these would cost about $50,000. Anticipated additional costs here to JLS&A range between $600,000 and $750,000.

- The value of existing overpacks, with a per-unit depreciated value of about $30,000 apiece, would be lost. For JLS&A, this cost component would be approximately $500,000.

Thus the overall cost of compliance for JLS&A would be, at the low end, slightly more than $2 million, and at the upper end, on the order of $8 million. These costs are incurred even if it is assumed that all existing devices will be able to be shipped legally in existing, requalified containers or new COC containers.

JLS&A is a firm with annual revenues and a total net worth in the mid-seven digits. Having to spend approximately one year's total revenues or its total net worth, or several times annual profits, on a short-order backfit that increases neither productivity, profitability nor safety, would

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[31] JLS&A's devices are not totally identical: they come in various models designed for customer-specific needs, which vary somewhat in size, dimensions and weight. However, there are two principal model "families", one designed for NRC COC containers and one designed for DOT Specification containers. JLS&A has two virtually identical outer containers manufactured under NRC COC 6280 in active service. It has also about 15 slightly smaller containers, similar but not identical to each other, manufactured to DOT Specification 20WC, in service. The NRC COC containers are intended for shipment of devices in one model "family", without being designed uniquely for specific devices within that "family." The same applies to the DOT Specification containers and devices within the other model "family." Thus, depending on the degree of flexibility granted by the NRC in licensing of new containers or requalification of existing ones, JLS&A would have to obtain anywhere between two and about a dozen new COCs, in order to account for the variations between different device models.

[32] Costs are distributed among engineering and design costs ($l00,000-$150,000), fabrication of one or more test prototypes ($50,000 apiece), testing and analysis ($100,000-$150,000) and NRC licensing fees and related costs ($120,000-$200,000).

[33] In the interest of simplicity, the factor of time will not be considered in this evaluation. Obviously, if the NRC finds itself with a large backlog of COC applications, the time required to approve them will increase.

[34] It is possible that outer containers already licensed to 1967 standards under an existing NRC COC could be requalified under the new criteria. However, because of historic differences between NRC and DOT requirements, particularly QA paperwork requirements, it seems unlikely that any DOT-Specification containers built to 1967 standards could ever be certified by the NRC unless the NRC interprets the documentation requirements of Part 71 Subpart H flexibly. Thus all DOT-Specification containers would, in all likelihood, have to be replaced.

be a sufficiently questionable economic decision that the company would, instead, regretfully, probably close its doors and go out of business.]

The NRC and Department of Transportation (DOT) must recognize that while IAEA standards generally have good technical bases, they are consensus standards that do not necessarily consider the risk-inform, performance-based aspects of regulations that we have developed in the United States. Therefore, while most of the IAEA standards should be incorporated into US regulations, the unique aspects of the US regulations need to be considered. The IAEA standards are appropriate for international shipments but the NRC and DOT regulations should also provide allowance for domestic-only applications. This would include for example, the grandfathering provision. While the IAEA provisions must apply to international shipments, for domestic-only shipments the grandfathering provision would allow the continued use of existing packages manufactured to the 1967 standard, but prohibit the manufacture of any new packages. Similarly, the A_2 value for molybdenum-99 and the A_1 and A_2 values for californium-252 should be retained for domestic use only packages. Further, provided they can be shown to meet the proposed regulations, the package identification number should be revised to the appropriate identification number prefix together with a suffix of "-96" provided that such packages shall be for domestic use only and no additional packages be fabricated. [Commenter No. 0019 - 0058]

I. Issue 9 - Changes to Various Definitions
   i. Overall Impact (including cost-benefit data)
   ii. NRC Proposed Position

J. Issue 10 - Crush Test for Fissile Materials Package Design
   i. Overall Impact (including cost-benefit data)
   ii. Issue-Specific Discussion

Monetized
Commenter No. 1090-0053: [*NRC Request for Information:* What are the cost or benefit impacts of imposing the crush test requirement on fissile material package designs?

Industry Response: The additional cost of the crush test for fissile materials is estimated at about $5,000,000. This is to design, certify and manufacture replacement packages for those currently in use for the shipment of uranium oxide. There are currently three to five packages currently in use that the industry believes will need to be slightly modified to assure they pass the crush test. Due to the limits on changes to these packages, re-certifications of the current CoCs will be required.]

Quantitative

Currently, NRC regulations require crush tests on certain type B fissile material packages (4). However, crush testing is not required for packages having a mass wearer than 500kg (1,100 lbs.) (5). According to DOE (6), rail SNF waste packages alone, not including the transportation casks, are estimated to weigh between 35,000 to 83,000 kilograms. Therefore, the rail casks will not be subject to crush testing. As part of its comments to NRC's re-evaluation of the modal study, AAR submitted a report to NRC entitled *"Rail Transport of Spent Nuclear Fuel - A Risk Review,"* G.W. English. et.al. July 1995 (revised 11/95; 6/96; 12/97) (7) That report indicated that the inclusion of the test for small packages is based on the logic that they are transported in large numbers and in combination with other packages; and as a result demonstrate a higher possibility of experiencing crush loads than large packages would. While large packages transported by truck (and to a certain extent by European-trains) may not be as susceptible to dynamic crushing as to impact loads, North American rail transport usually involves multiple vehicles with car characteristics that demonstrate a high probability of dynamic crush loads upon derailment. Train accidents by definition involve multiple vehicles. Vehicles in the train after a collision or a derailment are more often than not subjected to crush loads in the radial direction (8). [Commenter No. 1090 - 0137]

iii. NRC Proposed Position

K. Issue 11 - Fissile Material Package Design for Transport by Aircraft
  i. Overall Impact (including cost-benefit data)
  ii. NRC Proposed Position

L. Issue 12 - Special Package Authorization
  i. Overall Impact
  ii. Issue-Specific Discussion
  iii. NRC Proposed Position

M. Issue 13 - Expansion of Part 71 Quality Assurance Requirements to Certificate of Compliance (CoC) Holders
  i. Overall Impact
  ii. NRC Proposed Position

N. Issue 14 - Adoption of American Society of Mechanical Engineers (ASME) Code
  i. Overall Impact
  ii. NRC Proposed Position

O. Issue 15 - Change Authority for Dual-Purpose Package Certificate Holders
  i. Overall Impact
  ii. NRC Proposed Position

P. Issue 16 - Fissile Material Exemptions and General License Provisions
  i. Overall Impact
  ii. NRC Proposed Position

Q. Issue 17 - Double Containment of Plutonium (PRM-71-12)
  i. Overall Impact
  ii. Issue-Specific Discussion
  iii. NRC Proposed Position

Monetized

Commenter No. 1090-0040: [**Excessive Cost:** Double containment increases cost without measurable benefit. The costs to DOE of double containment for the period 2001 through 2010 is estimated to be over $60 million for transuranic waste and plutonium oxide shipments. In addition to the specific impacts cited above, not removing 10 CER 71.63 requirements could have significant cost impact from design, certification, and fabrication of future packaging, such as the TRUPACT III or the DPP-1 and DPP-2, needed to complete DOE's *Accelerated Cleanup* strategy for resolution of the legacy wastes and materials from the cold war.]

Quantitative

Commenter No. 1090-0008: [We also ask that NRC reject the proposal to allow plutonium to be shipped in single shelled containers, when double shells have been required for 30 years. Thousands of plutonium shipments are projected to go to the WIPP dump in New Mexico. The original WIPP shipping containers, TRUPACT-I were rejected because they only had single containment. Current and proposed WIPP containers have double containment. Reducing the required containment on plutonium shipments increases public exposure risk and the release risk from containers. The Environmental Evaluation Group at WIPP has documented that double containers are significantly safer than single. We oppose any weakening or indefensible substitutions in cask design requirements.]

Commenter No. 1090-0040: [**ALARA Inconsistency:** Double containment operations require more handling than single containment, which results in increased worker radiation exposure. Increased handling has caused and will cause unnecessary worker radiation exposure in the future during package operations, estimated to be 1200 to 1700 person-rem over a 10-year period. This penalty is attributable almost entirely to the additional operations required for double containment of TRU wastes. The impact of dealing with the additional collective dose at WIPP, which has self-imposed an administrative worker dose limit of 1 rem/yr, would be to use more workers or develop more restrictive work processes. Both methods would be costly and unwarranted.]

The Department of Energy supports the proposed removal of the requirement for “double containment” of plutonium from § 71.63. A single containment barrier is adequate for Type B packages containing more than 20 Curies of solid form plutonium. The Department of Energy conducted an in-depth analysis of the current double containment rule and identified the associated impact on worker health due to additional radiation exposure as well as projected increased operational costs. This proposed revision will reduce radiation exposure to personnel who open and close packages and will reduce the cost of packaging and its associated hardware. The excellent safety record of single containment Type B packages in 40 years of shipments, confirmed by DOE and NRC safety studies, as well as improved QA and analysis capability developed in that period, provide reasonable assurance that this revision to the Type B packaging standards for plutonium will provide adequate protection to public health, safety, and the environment during transport.

We recommend removal of § 71.63 because it has no technical basis for existence and presents a continuing cost to DOE without any commensurate safety benefits. The requirement for double containment (separate inner container) is particularly troublesome and inconsistent with the science and radiation protection basis for packaging all radionuclides. Particular problems with the current requirement include:

- Technical Basis: The proposed rule cites the inconsistency of double containment with the technical basis of the A_1 and A_2 values, and the Q-system principles of equating radiation effects. To continue the artificial requirement for double containment plutonium contained in 10 CFR 71.63 removes flexibility in package designs that might be needed to meet DOE's mission. Thus, the DOE urges NRC to eliminate the double containment requirement as early as practicable.

- ALARA Inconsistency: Double containment operations require more handling than single containment, which results in increased worker radiation exposure. Increased handling has caused and will cause unnecessary worker radiation exposure in the future during package operations, estimated to be 1,200 to 1,700 person-rem over a 10-year period. This penalty is attributable almost entirely to the additional operations required for double containment of TRU wastes The impact of dealing with the additional collective dose at WIPP, which has self-imposed an administrative worker dose limit of 1 rem/yr. would be to use more workers or develop more restrictive work processes. Both methods would be costly and unwarranted.

- Transportation Risk: The risk incurred by the public in incident-free transport relates principally to exposure to radiation from the package that cannot be eliminated. Double containment will have an impact on this source of risk because of elimination of an extra boundary. However, the reduction is likely to be relatively small. In an accident, removal of double containment may incur a small-calculated increase in public radiological risk. However, in any case, the dose rate is already small enough at distances where the public is likely to be exposed that the impact of single- or double contained material will not be consequential. [Commenter No. 1090 - 0171]

R. Issue 18 - Contamination Limits as Applied to Spent Fuel and High Level Waste (HLW) Packages
   i. Overall Impact
   ii. Issue-Specific Discussion
   iii. NRC Proposed Position

Quantitative

Contamination Limits as Applied to Spent Fuel and High level Waste (HLW) Packages: The Europeans may dismiss contamination "incidents" as having no radiological consequences, but that is not convincing, in view of recent research findings concerning adverse impacts of low-level radiation at the cellular and molecular levels. There should be no relaxation of radiation protection in any shipments, especially high-level wastes and intensely irradiated "spent" fuel. Although there have been comparatively few HLW/SF shipments in the put, the numbers may increase in near term years. For that reason maintenance of maximum control must be the principal goal of the NRC. [Commenter No. 1090 - 0128]

S. Issue 19 - Modifications of Event Reporting Requirements
   i. Overall Impact
   ii. NRC Proposed Position

III. DOT-Related Issues

IV. Other Issues

QUALITATIVE

I. General Comments

Commenter No. 1090-0028: [The United States Department of Transportation (DOT) and Nuclear Regulatory Commission (NRC) are proposing to weaken radioactive transport regulations at a time of potentially massive increases In nuclear waste shipments and the threats of deliberate terrorist attacks on shipments and use of radioactive materials for "dirt bombs."]

Commenter No. 1090-0039: [The sharp increase in projected nuclear waste and/or radioactive shipments should be evaluated in these proposed rule changes as it relates to all aspects of transport. The dramatic increase in radioactive shipments across the nation must be addressed by all federal government agencies involved because historically none of the agencies have had experience with the magnitude of shipments that are projected in the coming years and decades. Proposing rule changes that rely on “outdated" data is unacceptable.]

Commenter No. 1090-0008: [Neither DOT nor NRC believes that the enormous expected increase in the number of shipments needs to be considered in making these changes that will inevitably affect those shipments and the thousands of communities through which they will pass in the decades to come. In fact they are satisfied to use twenty year old data to justify “updated” rule changes, some of which reduce public safety. We argue that the real world situation and updated data must be used to estimate the impacts of the rule change. DOT and NRC should use more current data and future projections including the expected increases in actual nuclear shipments.]

Commenter No. 1090-0028: [Old data, lack of data, reliance on ICRP, reliance on computer model scenarios that may not he realistic to project doses, no calculations for more than 350 radionuclides.]

Commenter No. 1090-0046: [I understand that much of the data that has been used is outdated, and that there is a serious problem with lack of data on certain issues. Apparently there are over 350 radionuclides for which we do not have any calculations for at all. This is completely unacceptable.]

There are ever-increasing amounts of radioactive materials and both high- and low-level wastes being generated as a result of the nation's continuing reliance on commercial nuclear power reactors, on industrial, medical, and research uses, and the nuclear weapons facilities, some of which are being dismantled and cleaned up, others undertaking new nuclear weapons-related research. In their feasibility and safety analyses, however, the DOT and NRC are relying on long out-of-date ©. 1985) data and other outdated information about transportation conditions and about radiation health and safety impacts for their assessments of transportation performance and risks to populations and the environment. Current data must be obtained and used in order to formulate sound future projections about the impacts of these proposed rules. The computer codes that are used for these calculations must be reconsidered and made more accessible and transparent to the public. Independent examination and verification of the agencies' underlying assumptions, their models, calculations, and conclusions must be possible and required prior to any further action on these regulations. [Commenter No. 1090 - 0129]

The promulgation of this rule will be enabling of the commercial and military nuclear industries' desire to revive and expand, thereby generating ever more wastes to be stored, transported and ultimately - one had hoped - sequestered from the biosystem. The greater the amounts of such hazardous materials and wastes in circulation, the greater the danger and damage to human health and to other forms of life. [Commenter No. 1090 - 0128]

The already inadequate safety testing of transportation casks is to be opened to further weakening, thereby increasing the risks of significant, if not catastrophic, releases of the radioactive contents of shipments in the event of worst case accidents that exceed the design criteria and destructive proof-testing of the shipping containers. [Commenter No. 1090 - 0128]

Commenter No. 1090-0003: [Tens of thousands of shipments of irradiated nuclear fuel will be moving across this country and around its coastlines if the Yucca Mountain Project proceeds.]

Commenter No. 1090-0033: [Recently, the effort to ship nuclear waste to the Yucca Mountain site was approved. At this time, we do not oppose that plan to centralize nuclear waste. But it will undoubtedly result in a great deal of shipments of dangerous materials. In addition, the use of radioactive materials appears to be increasing in our advancing society, which results in more frequent shipments of other radioactive materials.]

Commenter No. 1090-0046: [This is of great concern to me, particularly in light or the enormous increases in nuclear waste transportation shipments that are likely to happen. It is very likely that nuclear waste transportation will be affecting thousands of **ADDITIONAL** communities in the next few years. Two proposed nuclear waste transportation routes (one rail and one highway) each lie within about 5 blocks of my house*. Considering the thousands of other communities that lie directly along future nuclear waste transportation routes, the Nuclear Regulatory Commission and the Department of Energy each need to keep in mind the incredible responsibility that they have to the public.]

Commenter No. 1090-0008: [The United States Department of Transportation (DOT) and Nuclear Regulatory Commission (NRC) are proposing to weaken radioactive transport regulations at a time of potentially massive increases in nuclear waste shipments and the threats of deliberate terrorist attacks on shipments and use of radioactive materials for “dirty bombs.”]

The draft rule opens plutonium transport containment to extremely significant weakening by elimination of requirements for double containment. Thousands of tons of plutonium will be shipped in coming years. Heightened risk of accidental or intentional release is not acceptable. [Commenter No. 1090 - 0128]

Commenter No. 1090-0049: [The ZEC wishes to emphasize that NRC's proposed rulemaking - without appropriate exemptions for natural materials and ores - would extend radioactive materials regulation to ores and natural materials having very low activity levels with resulting increased costs, transportation burdens and liabilities, all without justification.]

Commenter No. 1090-0049: [Paragraph 107(e) appropriately emphasizes that natural materials and ores that are not part of the nuclear fuel cycle or otherwise processed for their radionuclide content are outside the scope of the regulation. Because most minerals and natural materials contain detectable concentrations of natural radionuclides, the universe of materials that could be considered to be technically “radioactive” -- and potentially subject to regulation -- is very large. Importantly, IAEA recognized that the scope of regulatory control should limited by excluding ores and natural materials that are not exploited for their radionuclide content, provided a certain activity level is not exceeded.]

Commenter No. 1090-0049: [Second, Paragraph 107(e) expanded the exemption beyond ores to include ores and *natural materials* containing natural radionuclides. There are many materials of natural mineral origin that could not be strictly construed to be “ores,” but rather are products made from ores. Examples include high performance refractories used in extreme temperature applications such as foundries or glass furnaces and zirconia specialty ceramics. Moreover, in today's environmentally conscious market, many spent refractory materials retain their value as recyclable natural materials. That IAEA saw fit not to limit the scope of the exemption to “ores” promotes environmentally sound recycling practices for natural materials that incidentally contain natural radionuclides.]

The analyses on which risk determinations are based fail also to account for recent and current scientific research findings on low dose and low dose-rate irradiation at cellular and molecular levels. The argument of nuclear industry proponents that new information need not be considered is invalid since the NRC's legal mandate is to protect the public's health and safety. This mandate is violated by ignoring cautionary information that is now available in the peer reviewed literature. [Commenter No. 1090 - 0128]

Adoption of this rule will weaken regulatory control, or relinquish it altogether, over large amounts of radioactive materials and wastes, allowing increasing quantities into commerce and into the lives of individual citizens without their knowledge or approval. The consequence of this action will be to add potentially many multiple sources of undetected and undetectable exposures to individuals absent their consent. Such a rule violates the most fundamental premises of radiation protection, namely that (a) the individual recipient of an added dose should receive a benefit greater than or commensurate with the added risk of genetic or somatic injury, (b) should be fully informed, and ©) should be able to accept or reject the additional exposure. [Commenter No. 1090 - 0128]

Discussions in the texts of transport vehicle, container, and package testing are of concern to Sierra Club. Contrary to claims of a good transportation record, the nuclear industry has, over the years, experienced trucking accidents, spills, and lost or stolen materials. Other non-nuclear-related serious accidents, some involving hazardous materials, must reexamined and incorporated into revised risk analyses. In the contemporary climate of national security concerns, both older shipping containers and the sorely needed new and presumably safer canister designs must be subjected to far more stringent testing procedures to assure their ability to withstand damage and prevent releases: longer drops; greater crash impacts; longer and higher pressure water submersion; leakage resistance; higher, longer, more intense fire temperatures; and much greater explosive forces. [Commenter No. 1090 - 0129]

A concern regarding the actions to harmonize the US domestic regulations with the latest IAEA regulations is the slowness of these actions. GNP conducts global business and as a result, we are required to comply with the regulations of many countries and manyinternational organizations as well as those of the US. During these transitional times, GNF must therefore operate to two regulatory systems, one for domestic and one for international shipments. This places complex demands on our management systems, procedures, personnel and training.

For this reason, GNF believes that the transition to international standards needs to be streamlined so that this impact is minimized much better than is the case currently. [Commenter No. 1090 - 0143]

This proposed IAEA compatibility rule will also enable further expansion of federal preemptive regulatory authority over the states and municipalities which have obligations to protect their populations. This exercise of preemptive power is antithetical to the proper functioning of a democratic society, imposing additive biologic hazards without the consent of those exposed or of the governments most directly responsible for their protection. The U.S. populations that will be placed at heightened risk from radioactive waste in transit have had no opportunity to comment on or otherwise participate in the earlier formation of the IAEA rules. [Commenter No. 1090 - 0128]

Health effects analyses continue to utilize "standard man." The majority of the U.S. (And world) population is not composed of NRC's standard men. The impacts of potential exposures to the most susceptible portions of the population - ova, embryo, fetus, rapidly growing young child, elderly, and those with impaired health - are not the basis of the radiation protection standards or risks used in development of the Proposed Rule. In the event of accidental or intentional releases from radioactive materials and waste shipments, it is the impacts upon those segments of the population that should be the measure of damage assessments and risk analysis. [Commenter No. 1090 - 0128]

Commenter No. 1090-0041: [While we understand, especially those of us who ship internationally, the intent of the NRC to achieve harmonization with international transportation requirements, the current process used by domestic agencies to retrofit or otherwise adopt IAEA requirements in an inconsistent timeline needs to be changed. The timeliness of this process needs to be improved. Moreover, the two year cycle at which changes are now being transacted by IAEA in cooperation with the competent authorities is needlessly frequent, resulting in demands on the resources of both the competent authorities and the regulated community to adopt to changes that are unwarranted as they provide little value to a segment of transportation that, based on its track record, requires no improvement.]

II. Issue-by-Issue Comments

A. Issue 1 - Changing Part 71 to the International System of Units (SI) Only

i. Overall Impact (including cost-benefit data)

ii. NRC Proposed Position

Qualitative

Changing Part 71 to SI Units Only: This change should be rejected. All NRC regulations and guidance must retain the use of dual units, in accordance with its "Metrication" Policy. As indicated in earlier comments, use of only SI units has the potential to cause errors that can result in improper exposures to workers and members of the public, with adverse impacts also on licensees who may then be subject to litigation for damages. This issue's importance is underscored by a new report on the numbers of Iatrogenically-induced and other causes of preventable deaths in the U.S. medical care system, due to carelessness, lack of funds, or other systemic failures. We concur with the NRC's position on this issue. [Commenter No. 1090 - 0128]

No nuclear industry cost arguments should be considered by the Commission. Thrdughout its fifty years of existence, the AEC/NRC have totally ignored the very real economic costs to human health that are born by individuals who experience the cancers, leukemias, heart disease, mental retardation, and other ills that the National Academy of Science has identified with exposures to ionizing radiation. Those societal economic costs far outweigh any shipping costs that the nuclear industry might have to pay for proper double containment of its dangerous products. We urge that the NRC instead now incorporate the public health costs of radiation exposures, and undertake the assessment of the health consequences and costs to the affected public of the synergistic relationships of exposures to radiation in combination with exposures to the multitude of other toxic substances that have been released into the environment. [Commenter No. 1090 - 0128]

B. Issue 2 - Radionuclide Exemption Values

Qualitative

Commenter No. 1090-0028: [Old data, lack or data, reliance on ICRP, reliance on computer model scenarios that may not he realistic to project doses, no calculations for more than 350 radionuclides.]

Commenter No. 1090-0028: [ICRP does not represent the full spectrum of scientific opinion on radiation and health. Even though its most current risk estimates are used in this rulemaking, they do not take into consideration important information on the health impacts of radiation such as

- synergism with other contaminants in the environment and
- the bystander effect, in which cells that are near cells that are hit but are not themselves hit by ionizing radiation exhibit effects of the exposure. Other organizations are now formed to independently assess various aspects of radiation and health, so ICRP can be questioned and challenged.]

Commenter No. 1090-0028: [For the minority of radionuclides whose exempt values decrease lower than the existing 70 bq/gm, I could accept reducing the amount of material that would be exempt from regulation. However, this does not justify increasing the exempt levels for the majority of radionuclides in the Exempt Concentration Table arid accepting the Exempt Consignment Table.]

i. Overall Impact (including cost-benefit data)

Qualitative

Commenter No. 1090-0030: [The exemption threshold that is currently used by both DOT and NRC (where all radioactive materials that exceed a specific activity of 70 Bq/g are regulated in transportation and all materials below this threshold are exempt) is comparatively easy to verify. Under the proposed revision (where different materials would have different activity thresholds), “industry would expend resources to identify the radionuclides in a material, measure the activity concentration of each radionuclide, and apply the ‘mixture rule’ to ensure that a material is exempt” (67 FR 21398, April 30, 2002) and “Additional effort to characterize the material being shipped would increase occupational exposure” (Draft Environmental Assessment of Major Revision of I 0 CFR Part 71, NUREG/CR-6711, page 49) Thus, both the regulatory burden and worker exposure would increase.]

Commenter No. 1090-0035: [Although the revised limits are not expected to create any significant burden to the Naval Nuclear Propulsion Program (NNPP), use of the new limits could create a cumbersome work practice for some shipments. All low-level shipments that are currently exempt will require a detailed evaluation to ensure that activity concentrations for each radionuclide are acceptable. For example, thoriated tungsten weld rods and soil from site excavations would require individual isotope analyses at an additional expense. The NNPP considers that the current 70 Bq/g activity concentration limit for domestic shipments should be retained to avoid creating this cumbersome work practice for shipments that are currently made routinely.]

Commenter No. 1090-0030: [The above-quoted statement that “results were found to be similar” would presumably indicate that the exemption values adapted from SS- 115 to TS-R-I were found to be protective for transportation scenarios, but this is not the case. According to NRC’s *Federal Register* notice, the safe exemption values that IAEA calculated for transportation scenarios were lower than those found in SS-115, “but not by more than a factor of 100. IAEA did not believe the differences warranted a second set of exemption values, and therefore adopted the Safety Series No. 115 [SS-I 15] values in TS-R-1.” (67 FR 21396, April 30, 2002) In other words, the statement that “results were found to be similar” is misleading; it improperly conceals the fact that the IAEA transportation exemption values for some radionuclides are too high (by up to a factor of one hundred) to meet IAEA’s own safety goals and that IAEA “did not believe the differences warranted a second set of exemption values”]

Commenter No. 1090-0030: [The claimed “technical” benefits of the proposed revisions are thus extremely marginal and highly overstated. To say that they are based on “a rigorous technical approach” is misleading. Assuming (as indicated in the preceding paragraph) that the current regulations produce a 50-fold modeled exceedance of the 1 mrem/year criterion for transportation scenarios, and that the proposed NRC-DOT revision merely cuts this in half (creating a 25-fold modeled exceedance), we find that the effort and associated cost of the proposed revision greatly outweigh the benefit.]

Commenter No. 1090-0053: [*NRC Request for Information:* What impacts, if any, would result for industries that transport natural material and ores containing naturally occurring radionuclides which are not intended for processing for economic use of their isotopes (e.g., phosphate mining, waste products from the oil and gas industry), if the TS-R-1 exemption values are adopted, but without the “10 times the applicable exemption values” provision?

Industry Response: Even with the “10 times the applicable exemption values” natural material and ores containing naturally occurring radionuclides that are not to be processed for recovery of their radionuclides could still be transported, but not be exempt from the regulations. As discussed above, the industry does not want this to occur. As the Interagency Task Force learned, the regulations of other agencies, such as OSHA, afford adequate protection for workers and the public; the NRC does not need to enter into this regulatory arena. Therefore, we recommend that the exemption apply to the domestic transport of unimportant quantities of source material subject to the 10 CFR 40.13 exemption provided that the material and ores are not to be processed for economic recovery of their source material content.

The proposed radionuclide exemption values may impact waste disposal sites that are regulated by EPA under the Resource Conservation and Recovery Act (RCRA). The acceptance limit at these sites for materials containing radioactive residuals is the existing 70 Bq/g (0.002 Ci/g) standard which is used by DOT, NRC, and EPA. As only the NRC and DOT are proposing to adopt the exemption values, situations may arise whereby DOT regulations and the new exemption values would allow the transportation of materials with residual radioactivity, but the RCRA sites could not legally accept the materials for disposal.]

Commenter No. 1090-0053: [*NRC Request for Information:* What cost impacts or other problems, if any, would result from adoption of the exemption values, in Part 71 and DOT regulations, for industries or entities involved in the shipment and disposal of materials with residual activity to RCRA sites?

Industry Response: Adoption will raise some questions from the operators of RCRA disposal facilities and the public about the safety of the materials that were previously exempt from transportation labeling and that are not exempt under the new regulations. This could cause a perception of a change in risk. In practice, nothing will change for the RCRA facility accepting (or not accepting) the materials for disposal, as the regulations for those facilities do not change. The exposure to the facility workers and public will not change, as the material must still be within the 70 Bq/g (0.002 Ci/g) standard.]

Commenter No. 1090-0052: [In the case of exemption values for fissile material the proposed rule is overly conservative and places increased costs and unnecessary burdens on the industry, specifically, in the case of bulk shipments of contaminated materials, such as soil or building rubble. Further the proposed rule for fissile exempt material is incompatible with the international standards and will complicate the international shipment of such materials.]

Commenter No. 1090-0053: [*NRC Request for Information:* What impacts, if any, would result for industries that possess, use, or transport materials currently exempt from regulatory control (e.g., unimportant quantities of source material under 10 CFR 40.13) if adoption of the radionudlide exemption values were to occur in Part 71?

Industry Response: Adoption of the exemption values in TS-R-1 could result in the licensing of certain materials that are currently exempt from NRC regulation under 10 CFR 40.13. However, 10 CFR 71 shipping regulations would impose some packaging and labeling requirements. The NRC currently has an Interagency Task Force that is reviewing regulation of unimportant quantities of source material under the 10 CFR 40.13 definition. NEI understands that the Interagency Task Force has prepared and submitted recommendations to the Commission. Industry has recommended to the Interagency Task Force that unimportant quantities of source material currently exempt from regulations under 10 CFR 40.13 remain as such. Industrial and mineral beneficiation processes that concentrate radionuclides in excess of the 0.05% “unimportant quantity” limit and whose purpose is not the recovery of the source material should not be subject to NRC licensing and regulatory requirements.]

ii. Issue-Specific Discussion

Qualitative

Commenter No. 1090-0052: [Westinghouse anticipates that there will be an impact on the shipments of naturally occurring materials. Even with the proposed factor of 10 allowance provided in the proposed 71.14(a)(1), shipments of Zircon sand will now become regulated shipments that require the material to be shipped as LSA-I material. It is not dear that such materials represent a hazard that would warrant the imposition of additional shipping regulations. Westinghouse recommends that the NRC review this issue and consider a higher factor, such as a factor of 100, for naturally occurring materials.]

Commenter No. 1090-0052: [The wording utilized in the proposed 71.14(a)(1) is “Natural materials and ores containing naturally occurring radionuclides **that are not intended to be processed for use of these radionuclides**, … (emphasis added).” This wording requires the shipper to have knowledge of the intended use by the receiver of the material and this requirement is not reasonable. Such wording could also result in the situation where a shipper of a specific commodity would be required to ship a natural material to different receivers using different regulations. Regulations for the transport of such materials must be based only the radiological properties of the material being shipped. There would be no difference between the radiological considerations of natural material that is being shipped whether it is or is not intended to be processed for the for the use of the radionuclides. Westinghouse recommends that the words identified above in bold type be deleted from the proposed regulations even though this change would result in a minor wording incompatibility with the IAEA safety standards.]

Commenter No. 1090-0052: [The proposed exempt concentrations of Table A-2 appear to also result in a significant change in the requirements for the transportation of unimportant quantities of Source Material. The concentration of natural uranium in a material meeting the 0.05% limit of 10CFR40.13(a) is 355 pCi/g. This concentration exceeds the concentration limit of 270 pCi/g for Natural uranium in the proposed 71.14(a)(1). Similar examples are found for the exempt quantities given in 10CFR30.18. As a specific example, for Cs-137 the exempt quantity in Schedule B of 10CFR30 is 10 microCuries whereas the exempt consignment quantity limit of the proposed Table A-2 is 0.27 microCuries. Thus a quantity of Cs-137 that is exempt from licensing would have to be shipped as radioactive material under the proposed rules.]

Commenter No. 1090-0052: [Westinghouse recommends that the proposed exemptions for plutonium-244 provided in the proposed 71.14(b)(1) and (2) be deleted. A review of special form sources seems to indicate that there are no special form plutonium-244 sources available. Given the nuclear properties of this radionuclide and the expected difficulty of production of such material it is unlikely that such sources will be available. Thus the proposed exemptions are unnecessary for this specific radionuclide.]

iii. NRC Proposed Position

Qualitative

Commenter No. 1090-0003: [Your proposals to legalize the exemption of varying amounts of radionuclides from transportation regulatory control, allow greater contamination on surfaces of irradiated fuel and high level radioactive waste containers.]

Commenter No. 1090-0028: [Due to daily reminders about the danger of radioactive "dirty bombs," the government has been supplying detection equipment to watch for and prevent nuclear materials getting out of regulatory control. Absurdly, the US DOT and NRC are proposing to EXEMPT some of every radionuclide, including plutoniums, strontiums, cesiums, and hundreds of others, at various amounts and concentrations, from regulatory control. It is already enormously difficult and expensive to detect and find radioactive materials that might be used for dirty bombs. What sense does it make now to intentionally exempt shipments of radioactive wastes and materials from the existing controls, tracking and regulations that have been in place for decades? If the regulations are changed, various levels of radioactive wastes and materials would be considered no longer radioactive and free to be shipped as if uncontaminated.]

Commenter No. 1090-0008: [For the minority of radionuclides whose exempt values decrease lower than the existing 70 bq/gm, we could accept reducing the amount of material that would be exempt from regulation. However, this does not justify increasing the exempt levels for the majority of radionuclides in the Exempt Concentration Table and accepting the Exempt Consignment Table.]

Commenter No. 1090-0038: [New § 71.14 (redesignated from current § 71.10) would modify the concentration levels below which radioactive substances are exempt from regulation during transportation. For many radionuclides, the revised exempt concentrations would be higher than the existing exempt concentrations (e.g., 14 times higher for plutonium-237; 14,000 times higher for tritium; 142,000 times higher for argon-39). These higher exempt concentrations would create a higher risk of harm from radiation exposure from a transportation accident and also create new and inadequately analyzed uncertainties about deregulated radioactive materials in commerce.]

Commenter No. 1090-0038: [NRC's Environmental Assessment lists 69 radionuclides whose exemption limits would be raised by a factor of 14 or more under the proposed revision (i.e., whose new exemption limits would be 1000 Bq/g or greater). However, this list improperly omits 33 other radionuclides whose exemption limits would be similarly raised by a factor of 14 or more. (See Draft Environmental Assessment of Major Revision of 10 CER Part 71, NUREG/CR-6711, page 48, and cf. 67 FR 21472-84, April 30,2002, Table A-2.) Among the 33 radionuclides omitted from the list are iodine-125, plutonium-237, tritium, and technetium-99. The impacts or aising the exemption limits for these radionuclides have apparently not been considered in the Environmental Assessment.]

Commenter No. 1090-0038: [*Doses to transportation workers and the general public during normal operations.* NRC has relied primarily on analyses done by the International Atomic Energy Agency (IAEA) which showed that the average annual modeled dose of this type, based on 20 representative radionuclides, was about 0.50 mSv (50 mrem) for the current exemption values in 10 CFR Part 71 and about 0.25 mSv (25 mrem) for the proposed revision of the exemption values. (67 FR 21396, April 30,2002) Although the proposed revision cuts the average modeled dose in half; the dose is still much too high. One of IAEA's own exemption criteria is that the effective annual dose to a member of the public from a radioactive source or practice should be unlikely to exceed 10 mSv (1 mrem). (*Ibid)* Thus, the average modeled dose would still exceed IAEA's exemption criterion by a factor of 25. If a major regulatory revision is being carried out, thereby offering an opportunity to remedy an existing section of 10 CFR Part 71 that allowed a 5O-fold exceedance of a recommended dose, then the major regulatory revision should ensure a 50-fold dose reduction. In this case, the 2-fold dose reduction offered by the proposed revision is grossly inadequate.]

Commenter No. 1090-0038: [There has been no demonstration that the inconsistency with IAEA standards has caused any difficulty. Thus, that alone cannot justify these changes. NRC argues that, although the existing regulations "have provided adequate protection of the public health and safety," the proposed revisions would reduce modeled exposures by a factor of two. However, given the inadequacies of this model (e.g., its dependence on the specific radionuclides modeled), this justification is dubious. More important, the modeled exposures remain 25 times over IAEA's target level. Given the magnitude of a regulatory change, NRC should consider more appropriate revisions to 10 CFR Part 71 wherein substantial improvements to public health and safety are the primary goal.]

A second very disturbing theme throughout both Proposed Rules is the marked reliance of both agencies on exemptions from regulatory controls. In the Exemption Tables, many A1 and A2 radionuclides are assigned exemption values that will increase doses to the public (a few have lower values), but the net effect wilt be to establish, essentially, permissible dose standards for exposures to the public with no opportunity for any review, comment, or input from anyone. This action will be accomplishing indirectly what the NRC and other agencies have been prevented by citizen opposition and by law from doing since the late 1970's: namely, the deregulation, release, recycle, and reuse of radioactively contaminated materials and "low-level" radioactive wastes. When nuclear materials have been exempted from regulation at any stage of their "life cycle," they will be freed to be entered into commerce and to be refabricated into consumer products or for other purposes. This rule would thereby add to the exposures that may be received by members of the public and workers without their being able to know or to avoid these additional radiation doses from which they incur added risk of injury but derive no benefit. And these materials may also be engaged in international trade and reuses without any controls. They may be disposed of or abandoned without regard for any radiological hazard they may pose. All of these consequences are, to be blunt, an illegal way for these agencies to perform and they will be in violation of the provisions of the Administrative Procedure Act. At issue here are various. recently reported research findings on the damaging impacts of low-level radiation on cells, on molecular functioning, on human health. These advances in our understanding of radiation impact argue against allowing these materials to be exempted from strict regulatory controls and enforcement. For these reasons, it is strongly recommended that both agencies <u>not</u> rely on or permit exemptions. It is requested that NRC and DOT remove all provisions in these Proposed Rules that allow or encourage exemptions. [Commenter No. 1090 - 0129]

Commenter No. 1090-0043: [Uranium and thorium levels in phosphate, gypsum, and coal cannot be considered safe because they are naturally occurring. From a public health point of view, there is no need to determine whether alpha emissions above the 70 Bq/g (0.002 mCi/g) threshold are naturally occurring or man-made, their effect on somatic cells and germ cells is the same. The NRC, DOT, and the IAEA have not made a substantial case regarding the shipment of ores and fossil fuels with regard to radioactive levels of naturally occurring rudionuclides. Frankly, we doubt that such a case could be made or that continued industrial use of these materials requires a reduction in the HMR standard. We hereby request that NRC and DOT provide us their analysis of the regulatory burden of radionuclide HMR on the fertilizer, construction, and fossil-fuel energy industries.]

Commenter No. 1090-0049: [However, there are ores in nature where the activity concentration is much higher than the exemption values. The regular transport of these ores may require a consideration of radiation protection measures. Hence, a factor of 10 times the exemption values for activity concentration was chosen as providing an appropriate balance between the radiological protection concerns and the practical inconvenience of regulating large quantities of material with naturally occurring low activity concentration.]

Commenter No. 1090-0049: [As discussed at the June 24, 2002 public meeting, there are vast quantities of natural materials and ores of critical importance to the U.S. economy that are routinely transported in commerce. Many of these ores exceed 1 Bq/g uranium, and could become "radioactive" materials for transportation purposes if NRC fails to implement IAEA's exemption provisions. These materials include:

A. Phosphate ore and fertilizer. According to the U.S. Environmental Protection Agency ("EPA") *Diffuse NORM Wastes - Waste Characterization and Preliminary Risk Assessment(Draft)*(Contract No. 68-D20-155, April, 1993)(hereinafter, "EPA NORM Report"), phosphate ores range up to 10 Bq/g uranium. The U.S. Geological Survey ("USGS") reports that 32,800,000 metric tons of phosphate ore were mined in the United States in 2001. (See: U.S.G.S. Mineral Industry Surveys for Marketable Phosphate Rock, March 2002). EPA's NORM Report relates that "average" phosphate fertilizer contains 4.2 Bq/g uranium isotopes."

B. Zirconium ores. Zirconium ores in the form of zircon sand typically contain 2.5 to 3.5 Bq/g uranium and 0.5 to 1.0 Bq/g thorium, in equilibrium with decay progeny. U.S.G.S. reports that over 100,000 metric tons of zircon entered into commerce in 2001 *(Id.).*

C. Titanium minerals. The titanium minerals (ilmenite, leucoxene and rutile) are recognized to contain low, but measurable, concentrations of uranium and thorium, at up to 1 Bq/g. U.S.G.S. reports that 300,000 metric tons of titanium minerals were produced in the U.S. in 2001 (Id).

D. Tungsten ores and concentrates. Tungsten mineral ores and ore concentrates are known to contain naturally occurring uranium and thorium up to and, in some cases, exceeding 1 Bq/g concentration. Based on information reported by U.S.G.S, it is estimated that around 10,000 metric tons of tungsten ore entered into commerce in 2001 *(Id).*

E. Vanadium ores. Vanadium ores may contain up to several Bq/g uranium. U.S.G.S. reports 2001 U.S. consumption of vanadium was 3,600 metric tons.

F. Yttrium and rare earths. Rare earth minerals may contain several Bq/g uranium and thorium, with some exceeding "source material" levels of 10 C.F.R. Part 40. Data available from U.S.G.S. suggests that U.S. yttrium and rare earths ore production totaled less than 100 metric tons in 2001.

G. Bauxite and alumina. EPA's NORM Report identified 2.13 Bq/g total activity concentration for bauxite According to U.S.G.S., over 12,000,000 metric tons of bauxite and alumina were consumed in the U.S. in 2001.

H. Coal and coal fly ash. U.S.G.S, in *Radioactive Elements in Coal and Fly Ash: Abundance, Forms, and Environmental Significance* (Fact Sheet FS-163-97, October, 1997), reports that while U.S. coals contain 1 to 5 ppm uranium, the element becomes concentrated by at least an order of magnitude in coal fly ash. It is estimated that hundreds of millions of tons of coal fly ash are transported annually in the U.S.

From the above discussion, it can be seen that an immense quantity of mineral ores and products containing low levels of uranium and/or thorium are transported annually in commerce. Many of these materials exceed 1 Bq/g, and failure to implement IAEA's exemption for natural materials and ores would dramatically expand the universe of materials regulated as "radioactive" for transportation purposes.]

Commenter No. 1090-0038: [The proposed revisions would also create a more complex scheme for determining whether shipments are exempt, such that "industry would expend resources to identify the radionuclides in a material, measure the activity concentration of each radionuclide, and apply the 'mixture rule' to ensure that a material is exempt" (67 FR 21398, April 30,2002), and such that "[a]dditional effort to characterize the material being shipped would increase occupational exposure." (Draft Environmental Assessment of Major Revision of 10 CER Part 71, NUREG/CR-6711, page 49).]

Commenter No. 1090-0038: [The proposed revisions also introduce new and inadequately analyzed uncertainties about deregulated radioactive materials in commerce. For example, an inspector could not determine compliance with the law simply by measuring the amount of radioactivity from the shipped material. A far more complicated test would be required. Given that most enforcement staff are overburdened, this increased complexity will inevitably lead to less enforcement and, ultimately, less compliance.]

Commenter No. 1090-0038: [The proposed regulatory revisions, while they would make the NRC and DOT standards compatible with each other and with the IAEA standards, would also create an inconsistency with U.S. Environmental Protection Agency (EPA) standards under the Resource Conservation and Recovery Act (RCRA). The current exemption threshold used by both DOT and NRC for transportation (all radioactive materials below 70 Bq/g are exempt) is consistent with EPA's 70 Bq/g acceptance limit for disposal of radioactively contaminated waste at RCRA-regulated waste disposal sites. "Presently, only the NRC and DOT are proposing to adopt the [new] exemption values, which may result in situations where shipment of materials with residual radioactivity would be allowed for transportation under the new exemption values but would not be allowed for disposal in RCRA sites." (67 FR 21394, April 30,2002) This inconsistency is likely to sow confusion among the regulated industry, lower compliance with EPA regulations, and reduce trust in federal standards.]

Commenter No. 1090-0049: [Note that some nuclides listed in Table I have a reference to footnote (b). These nuclides have the radiological contributions from their daughter products (progeny) already included in the listed value. For example, natural uranium [U(nat)] in Table I has a listed activity concentration for exempt material of 1 Bq/g (2.7x 10-5 uCi/g). This means the activity concentration of the uranium is limited to 1 Bq/g (2.7 x 10-5 uCi/g), but the total activity concentration of an exempt material containing 1 Bq/g 92.7 x 10-5 uCi/g) of uranium will be higher (approximately 7 Bq/g (1.9 x 10-4 uCi/g)) due to the radioactivity of the daughter products.]

Radionuclide Exemption Values: We oppose the adoption of NRC rules that allow exemptions of radionuclides from regulatory control. Adoption of even a one millirern per year dose standard opens the way for many "small" doses to individuals without their knowledge or consent from these sources, in addition to the many other sources of radioactive materials and "low-level" wastes, NORM, TENORM, and depleted uranium. Our opposition to a one mrem per year standard does not mean that we favor the 70 Bq/g ©. 50 mrem average) alternative; we are in opposition to adoption and use of that exemption standard as well. From the NRC's own diagrams of its proposed "exemptable" exposures, it is evident that that agency has anticipated increasing levels of allowable doses. (See appended diagrams.) ** We assume that it, and perhaps others, still do. [Commenter No. 1090 - 0128]

C. Issue 3 - Revision of A_1 and A_2

i. Overall Impact (including cost-benefit data)

Qualitative

Commenter No. 1090-0053: [*NRC Request for Information:* What impacts, if any, would result for the radiopharmaceutical industry in terms of cost and worker dose by adopting the lower international A_2 value, rather than retaining the current A_2 value for domestic shipment of molybdenum-99?

Industry Response: Impacts on worker dose are difficult to quantify. Intuitively, we believe the dose to workers will increase due to their need to handle more packages. As the limits per package transported will remain constant as far as contamination and direct exposure are concerned, regardless of the contents, occupational exposures will likely increase as workers will be handling a larger number of packages. Molybdenum-99 is the principal isotope used in medical imaging. As demand for this product can only increase with an aging population, by not retaining the current A_2 value a greater number of shipments will be required and this will result in higher per-treatment costs and higher costs for the industry.]

Commenter No. 1090-0041: [The scientific basis for the changes to the A_1/A_2 values is understood and justified. However, we agree with the provision in Table A-1 of Appendix A to Part 71 to maintain the exception to allow domestic Type A_2 limit of 20 Ci for Mo-99 and appreciate NRC's understanding of the justification for this. This is needed to allow domestic manufacturers to continue to provide Mo-99 generators to the diagnostic nuclear medicine community. A change in the A_2 limit to the value in TS-R-I would result in an increase in the number of packages ship and, therefore, and increase in the doses received by manufacturers, carriers and end users. Contamination Control]

ii. Issue-Specific Discussion

Qualitative

Commenter No. 1090-0028: [Old data, lack or data, reliance on ICRP, reliance on computer model scenarios that may not he realistic to project doses, no calculations for more than 350 radionuclides.]

Commenter No. 1090-0028: [ICRP does not represent the full spectrum of scientific opinion on radiation and health. Even though its most current risk estimates are used in this rulemaking, they do not take into consideration important information on the health impacts of radiation such as

- synergism with other contaminants in the environment and
- the bystander effect, in which cells that are near cells that are hit but are not themselves hit by ionizing radiation exhibit effects of the exposure. Other organizations are now formed to independently assess various aspects of radiation and health, so ICRP can be questioned and challenged.]

Commenter No. 1090-0053: [*NRC Request for Information:* What impacts, if any, would result for industry in terms of cost and worker dose by not including in Table A-1 (A_1 and A_2 Values for Radionuclides) the 16 radionuclides that are listed in the current Part 71 but not in TS-R-1?

Industry Response: Appendix A to Part 71 now contains A_1 and A_2 data for sixteen radionuclides that are not included in Table A-1 in TS-R-1. Commission approval is required to set A_1 and A_2 values for a radionuclide, although in the absence of data for a specific radionuclide, a licensee may use the *General Values for A_1 and A_2* presented in Table A-2. By omitting from Appendix A the A_1 and A_2 values for the sixteen radionuclides that are not in TS-R-1, the Commission is exposing itself the likelihood—almost certainty—of having to set such radionuclide values upon the future request of a licensee. As we know of no challenges to the health and safety bases for the sixteen radionuclides, we recommend that the NRC not delete them from Part 71, Appendix A. The NRC will save itself the cost and staff resources of establishing appropriate A_1 and A_2 values in the future and industry will be saved from another unnecessary regulatory burden.]

The NRC is proposing to make a conforming change to 10 CFR 71 to adopt the new A_1 and A_2 values from TS-R-1. Revising A_1 and A_2 values may have adverse impact on currently certified casks. The proposed regulation does not appear to ensure that transport casks certified under previous revisions will still be usable without modification or analysis in the future. This change should ensure that any transport casks certified under earlier revisions of the regulation would still be usable regardless of the revision of the regulation in effect at the time of shipment. [Commenter No. 1090 - 0057]

iii. NRC Proposed Position

Qualitative

Comment No. 1090-0044: [Even assuming that no one could prove that exposure to the proposed contaminant levels would increase the risk of damage to tissues, cells, DNA and other vital molecules, such a current lack of proof fails to acknowledge the fact that scientists, physicians and biologists continue to learn more about an increasing range of damaging effects from radiation --- including programmed cell death (apoptosis), genetic mutations, cancers, leukemia, birth defects, and reproductive, circulatory, immune and endocrine system disorders.

Just recently, for example, evidence of elevated mutation rates has been found in families living downwind of a Soviet nuclear weapons test site in Kazakhstan. (Yuri Dubrova, et al., "Nuclear Weapons Tests and Human Germline Mutation Rate," Science 8 Feb. 2002, pp. 946 and 1037.)

In the April 1999 Proceedings of the National Academy of Sciences ---just three years ago--- it was reported that radiation can induce mutations not only when it hits the nucleus of a cell, but when it hits the cytoplasm (the body) of the cell as well. "When DNA in the nucleus is struck by a particle, the damage often kills the cell. Cytoplasmic irradiation may be more dangerous, the [Columbia University accelerator] researchers suggest, because it generally does not kill the cell, and the mutation can be passed on to future generations of cells." (Nuclear News, 7/99, p.70)]

D. Issue 4 - Uranium Hexafluoride UF_6 Package Requirements
   i. Overall Impact (including cost-benefit data)
   ii. Issue-Specific Discussion

Qualitative

Commenter No. 1090-0008: [ICRP does not represent the full spectrum of scientific opinion on radiation and health. Even though its most current risk estimates are used in this rulemaking, they do not take into consideration important information on the health impacts of radiation such as

(A) synergism with other contaminants in the environment and

(B) the bystander effect, in which cells that are near cells that are hit but are not themselves hit by ionizing radiation exhibit effects of the exposure.

Other organizations are now formed to independently assess various aspects of radiation and health, so ICRP can be questioned and challenged.]

iii. NRC Proposed Position

Qualitative

Commenter No. 1090-0053: [*Industry Position:* Industry supports the NRC position, but with the following caveat. As drafted, the proposed § 71.55(g) would restrict a UF_6 package contents to a maximum enrichment level of 5% ^{235}U. This is problematic, as the NRC would be codifying an enrichment level that will likely be exceeded in fuels for new generation reactors or for higher burn-up levels. For higher enrichments, any UF_6 packages would, therefore, need to meet the requirements of § 71.55(b). This would likely necessitate fairy significant changes to (and costs for) the type of UF_8 packages currently used by the industry.]

Commenter No. 1090-0053: [*NRC Request for Information:* Should the current practice of excluding moderators in criticality evaluations for UF_0 packages *be* continued?

Industry Response: The current practice of excluding moderators in criticality evaluations for UF_6 packages should be continued. The justification for excluding it has not changed and there have not been any experiences to indicate that it should be changed. Therefore, it should be retained.]

E. Issue 5 - Introduction of the Criticality Safety Index Requirements
  i. Overall Impact (including cost-benefit data)
  ii. Issue-Specific Discussion
  iii. NRC Proposed Position

Qualitative

Commenter No. 1090-0053: [*NRC requests information:* What cost or benefit impacts would result if the per package Criticality Safety Index (CSI) were to change from 10 to 50?

Industry Response: The increase of the CSI from 10 to 50 would have a major detrimental impact in shipping and intermodal storage areas. This could increase the number of shipments to avoid the staging of the packages at a storage facility incident to transport. The NRC is proposing changes to Part 71 that would dramatically impact international transports of fissile material. § 71.22(d)(3) and § 71.59©)(1) would limit the sum of the CSIs to less than or equal to 50 when the material is stored incident to transport. This would mean that a shipment resting at a port after being unloaded from an ocean vessel and awaiting loading on a truck for onward shipment would be limited to a combined CSI of 50. As noted earlier, this change would effectively remove the exclusive use authorization for multi-modal shipments. Cost increases would be incurred in the documentation and scheduling areas. It would also increase the cost in customs handling and applications for import or export. It would increase the actual shipping cost, as higher rates would be charged due to smaller shipments. Demurrage fees would increase as less than fully loaded seapacks would be employed. Specific numbers are hard to identify, but it is clear this change would have a major detriment to shipping costs.]

We strongly oppose, however, the proposed text in 71.59©)(1) that would restrict accumulations of fissile materials to a total of CSI = 50.0 in situations in which fissile materials are stored incident to transport. Multimodal and international shipments are, by their very nature, subject to storage incident to transport (even if only for short durations).

Adoption of the Proposed Rule as drafted would effectively remove the ability to transport internationally and/or by multiple modes under exclusive use conditions. The Proposed Rule is silent on the intent behind this proposed change.

This seemingly arbitrary restriction on storage incident to transport would negatively impact the international movement of fissile materials, including the transport of fissile commodities to the United States under existing national nonproliferation programs.

On an annual basis, TLI transports thousands of packages containing fissile material to, from or through the United States on an international and/or multimodal basis under exclusive use conditions. Packages in these shipments are controlled with regard to accumulation in transport conveyances and are stowed and segregated for both radiation and criticality control purposes. These controls are documented in exclusive use instructions disseminated to entitles involved in the shipment (including the carrier). [Commenter No. 1090 - 0138]

F. Issue 6 - Type C Packages and Low Dispersible Material
   i. Overall Impact (including cost-benefit data)
   ii. Issue-Specific Discussion

Qualitative

Commenter No. 1090-0053: [*NRC Request for Information* on the need for Type C packages, specifically on the number of package designs and the timing of future requests for Type C package design approvals.

Industry Response: Currently the industry is not using any packages that would be replaced by a Type C package. As the program for the use of mixed oxide fuel advances, Type C packages may be required for shipment of some of these materials in the oxide form. Additionally, as international non-proliferation programs grow and expand with weapons grade materials being shipped and down-blended for commercial applications, Type C packages may be required to ship high enriched uranium oxide. Therefore, the industry recommends that the NRC and DOT work with the IAEA to limit the scope of Type C packages now, rather than later, when Type C package shipments are scheduled to occur and when package approvals may be more controversial.]

Type C packages and Low Dispersible Material: The insufficient testing requirements for Types B and C packages are ample reasons for rejecting the IAEA permission for use of the less protective Type B packaging for materials in air transport. September 11, 2001, also included a terrorist attack that resulted in the crash and destruction of a commercial aircraft of a type that might transport radioactive materials or wastes. Note also the extraordinary accidents cited above. The rigor of both Type B and Type C performance testing must be upgraded, not diminished, to meet the greater threats of accidents and of acts of terrorism (based now on experiences, not theoretical events). A Type C package may well be exposed to fire at extreme temperatures and far longer than the one hour mentioned. There is no excuse for the NRC to fail its national security obligations to assure a far higher level of safety restrictions and requirements than were deemed to be appropriate in the more naive past. More stringent Type C and Low Dispersible Materials worst case proof testing requirements should be adopted. Type C containers should be required to assure the highest probability that packages will survive unbreached. [Commenter No. 1090 - 0128]

iii. NRC Proposed Position

Commenter No. 1090-0041: [We support NRC's proposal to not adopt the requirements for Type C packages and Low Dispersible Material. The IAEA requirement considered additional performance criteria that reflect those in the NRC requirements in 10CFR71.64 and 71.74 for air shipments of plutonium. In the course of IAEA revision, these requirements evolved into the Type C package requirements and were expanded to include all radionuclides. While most member states took the position that these requirements would only impact a few shipments other than plutonium, the impact would be significant on radionuclides such as Co-60, The need nor the benefit have been demonstrated for these requirements and therefore the cost cannot bejustified.]

G. Issue 7 - Deep Immersion Test

i. Overall Impact (including cost-benefit data)

Qualitative

Commenter No. 1090-0035: [If older, previously certified packages can no longer be "grandfathered' (see Issue 8 below), then significant effort would be required to show that they meet the deep immersion test with little safety benefit for the shipments. The NNPP does not consider that this additional effort would be worth any benefit obtained.]

ii. NRC Proposed Position

H. Issue 8 - Grandfathering Previously Approved Packages

i. Overall Impact (including cost-benefit data)

ii. Issue-Specific Discussion

Qualitative

Commenter No. 1090-0035: [The enclosure contains Naval Nuclear Propulsion Program (NNPP) comments on the proposed revision to 1OCFR7l. Particular attention is directed to Issue 8 concerning "grandfathering" of previously approved packages. If invoked as proposed, the 10CFR71 revision is anticipated to cause the unnecessary handling of already-packaged unirradiated fuel and could impair the Navy's operational flexibility to refuel and defuel the Nation's nuclear powered warships. Should the NRC conclude that these "grandfathering" provisions be adopted, the NNPP requests a meeting with the NRC to discuss specific technical issues, such as the unique ruggedness of NNPP fuel, that would support the continued use of certified NNPP containers with satisfactory safety records.]

Commenter No. 1090-0035: [The NNPP maintains an inventory of new fuel in long-term storage to support a potential need to refuel the Nation's nuclear powered warships. This fuel must be stored until the warships are refueled or decommissioned. Several loaded steel containers in storage would require significant reevaluation and possible modification or replacement if the new rules are adopted. Any modification or replacement would involve unnecessary handling of nuclear fuel. Based on the unique rugged nature of NNPP fuel, which is designed and built to operate aboard naval warships during combat conditions and endure battle shock in excess of

50 G's, the NNPP considers the modification or replacement of certified NNPP containers with satisfactory safety records unnecessary.]

Commenter No. 1090-0035: [While all currently planned needs for shipping NNPP spent fuel are met with —140 shipping containers [NRC Certificate of Compliance USA/6003/B(U)F], the NNPP maintains a fleet of —130 spent fuel shipping containers [NRC Certificate Of Compliance USA/6003/B( )F] for operational flexibility in the event an emergent need develops to refuel or defuel a nuclear powered warship. Since the —130 shipping containers are certified to rules prior to the 1983 revision of 10CFR71, adopting the revised "grandfathering" rule will eliminate this operational flexibility in three years after the revision takes effect. The NNPP maintains that shipment of spent fuel in an —130 shipping container is safe; the NRC should consider allowing continued "grandfathering" of certified NNPP containers with satisfactory safety records.]

iii. NRC Proposed Position

Qualitative

Commenter No. 1090-0005: [I would like to reiterate how important Issue # 8, *Grandfathering Previously Approved Packages* is to the future success of International Isotopes, Inc. (I^3), as well as other small businesses that routinely transport Type B quantities of radioactive materials domestically. Although I^3 applauds the efforts of the Nuclear Regulatory Commission and the Department of Transportation to grandfather previously approved packages, we find it difficult to understand why some packages with proven safety records would unjustly be phased out for domestic shipments in as little as two years after the proposed rule is issued. I^3 has invested significant resources into transportation packages designed specifically for certain applications that will no longer be authorized for use should the regulations change as proposed.]

Commenter No. 1090-0005: [Cost aside, however, it is unlikely that the NRC would approve any new containers before the implementation date. Therefore adoption of the new regulations will eliminate our Company's ability to provide a domestic supply of critical radioisotope for both U.S. commercial and military applications and will dictate that only foreign Companies import this material.

A second concern we have is that the proposed rules would essentially remove from service any and all containers that could be used to transport isotopes from the Department of Energy's Advanced Test Reactor for medical or industrial use. In order to use this rare domestic reactor source for isotope production a new transportation package would have to be constructed that would meet the Safety Series 6, 1985 criteria. The time and cost associated with the design, manufacture, testing, and approval of such a container would likely exceed the financial ability of our Company.]

Commenter No. 1090-0042: [There is no compelling safety case to be made for the proposed elimination of 1967-Specification packages. There is no demonstrable harm to be avoided by "sunsetting" these packages; there is no demonstrable safety gain to be achieved by requiring their replacement with newer designs. Packages built pursuant to NRC COCs have an excellent safety record. So have packages built pursuant to DOT Specifications 7A/20WC. Both NRC and DOT agree that the current level of safety is satisfactory. This proposed change may be legitimately needed for uniform regulation of international shipments, but is not needed for safe, uniform regulation of domestic shipments.]

Commenter No. 1090-0042: [It may be literally impossible to qualify devices built for shipment as DOT Specification 7A packages in DOT Specification 2OWC containers at any cost because these devices lack the "QA Paper" required under the NRC's regulations at 10 CFR Part 71, as implemented by the NRC Staff. The same is also true of packages built pursuant to NRC COCs prior to implementation of the Part 71 QA program. As a result, literally thousands of Type B quantity sources, which have been shipped in 1967 Specification packages and which cannot be shipped economically if at all in any other licensed packages, will become stranded at hundreds of disparate current locations throughout the country. While "workarounds" of various kinds are technically imaginable, their costs seem likely to be prohibitive. The result will be that these packages will have to be maintained and kept safe indefinitely from radiological and safeguards/security standpoints. This is not a sensible result at any time, particularly one of heightened concerns about terrorism.]

Commenter No. 1090-0042: [Packages designed and built to 1967 specifications and properly maintained have an excellent safety record over the years. Neither agency alleges any safety problem with their design, which was subjected to 30-foot drop, fire and immersion tests by Sandia Laboratory in 1968.[35] Indeed, the NRC concedes, in its discussion of the proposal to eliminate use of 1967-
specification containers, that there is no safety benefit to doing so: "In terms of protection of public health and safety, the existing and proposed requirements are believed to be equally protective. Thus, neither an increase nor a decrease in potential health and safety impacts is expected as a result of adopting the proposed administrative changes." 67 Fed. Reg. 21406 col. 2. See also 67 Fed. Reg. 21394 col.1.

The NRC rulemaking notice lists six changes that have occurred in the regulation of package design since promulgation of the 1967 Safety Series 6 criteria. 67 Fed. Reg. at 21406 (col. 1). While it is true these changes have occurred, all of them have either been accounted for or do

[35] J. A. Sisler, "New Developments in Accident-Resistant Shipping Containers for Radioactive Materials", Sandia Corporation, 1968 (Exhibit 3). The drop and fire tests are consistent with current requirements, cf. id. with 10 CFR § 71.73 (DOT has explicitly adopted NRC standards on this issue, see 49 CFR § 173.467). The water-submersion test was for only 3' above the topmost surface. However, because the shielding in 1967-specification inner containers consists of heavy metal in 100% welded containments, independent calculations show that immersion to 10 meters will have no effect on the inner container: Water pressure at ten meters is only 13 pounds per square inch, as contrasted with the 3600 PSI crushing strength of plywood used in 20 WC-5 or 20 WC-6 containers, and the 30,000 PSI yield strength of the steel outer cover of 20 WC-6 containers or the steel outer container of 7A containers. The Sandia tests also did not include a 40-inch fall onto a 6-inch spike. However, the author of the report believed that "meeting this requirement is not considered to be a problem." Independent calculations confirm this conclusion. They show that a steel-jacketed 20 WC-6 container weighing the maximum of 1000 pounds will crush 2.5" of plywood when dropped onto a spike from 40", and that a 20 WC-5 container weighing the maximum of 4000 pounds will crush 3.5" of plywood. Compared with the minimum of 6" of plywood required by 49 CFR § 178.362-2, it is clear that the 40" drop onto a spike is not a problem for a 20WC-5 or 6 container.

not pertain to domestic special form Type B shipments.[36] Design evolutions are inevitable over time; and the fact of these changes does not establish that 1967-specification containers are unsafe or unfit for further use. Nor is any such claim advanced in either rulemaking proposal.[37]]

Commenter No. 1090-0042: [Applied to domestic shipments, it is likely to have far different effects than those intended. It will impose high, probably unbearable costs for JLS&A and other small but important business entities operating this area. Thus, rather than simply phasing out a widely used and serviceable but older class of container, it will either substantially weaken firms like JLS&A or literally drive them out of business with no ready successors.]

Commenter No. 1090-0042: [There is a potential for substantial delay in approving new designs or recertifying existing designs. Any "sunset" deadline on use of any package design being phased out under this proposal should permit its continued use pending ultimate decision by the NRC on either recertification of the existing design or approval of a new design, as long as (1) a good-faith, substantially complete application for approval or recertification, as the case may be, has been filed with the NRC at least 12 months before the nominal "sunset date" on use of the existing design, and (2) the application for approval or certification clearly is clearly related in the application to a design which is subject to the "sunset" provision.]

Commenter No. 1090-0042: [The proposed prohibition on use of containers manufactured to the 1967 standards would, if applied to domestic shipments within the United States, have severe effects. It would require JLS&A and the other businesses that ship significant quantities of radioactive material in them either to requalify, relicense, and probably rebuild, virtually all of their current shipping containers pursuant to a new COC from the NRC within two years (proposed DOT requirement) or three years (proposed NRC requirement), or to cease shipping. While the total extent and cost of this effort can only be estimated parametrically at this point since it would depend significantly on the flexibility with which NRC would implement its COC reviews, there is no question that it would be substantial, and that it would probably put JLS&A and other small businesses like it out of business. In that case, the proposal would also make devices and sources now shipped in these packages not legally shippable in any currently

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[36] Changes which are irrelevant include immersion tests for Type A packages [67 Fed. Reg. at 21406 col. 1, item 3] (the packages at issue here are Type B packages, which were already subject to immersion tests); addition of maximum normal operating pressure [item 4] (Type B packages at issue here do not need, and do not use, venting or active cooling); environmental test conditions [item 5] (Type B packages have always been tested within these parameters). Changes whose intent has been satisfied include use of A_1 and A_2 system and associated containment system performance criteria [items 1 and 2] (all Type B shipments are made in accordance with those limits); and QA requirements [item 6] (All packages approved for use by NRC since 1979 have met NRC QA requirements; the only gap is in documentation for packages designed pursuant to DOT Specifications. Even then, neither NRC nor DOT asserts that these packages, as a class, are inadequate in either design or construction.). For further detail, see JLS&A comment letter, September 29, 2000, at pp.5-7.

[37] JLS&A understands that DOT has expressed concern about the consistency of some DOT-specification packages with their design documentation or its regulations, and about maintenance of some such containers. This is a valid concern. However, it is a normal licensing and enforcement issue, not one going to the adequacy of the design specification itself. If shippers cannot produce satisfactory documentation, or if their packages are found to be in substandard condition, DOT can compel removal of any such packages from service and take other appropriate action. But this concern is not a rational basis for removal of an entire reliable class of container from service.

licensed container, thus creating hundreds of sites with thousands of orphan sources that could no longer be used, could not be shipped for orderly disposition, and would have to be maintained and safeguarded indefinitely. The bases for this concern are outlined below.]

Commenter No. 1090-0042: [At some point every device containing a radioactive source needs either a fresh source, or refurbishment, or retirement. At that point if it (or a replacement source) cannot be shipped for service or disposal, it becomes an "orphan source" – inoperable, but immovable. If JLS&A and other firms now relying on 1967-Specification containers are driven from business by the cost of conversion, these devices will become orphan sources. Facility managements, in coordination with state governments (in Agreement States) or the NRC, must then store them safely, indefinitely, keeping them physically secure, protecting personnel against radiological hazards, and guarding against safeguards hazards including, in the current environment, the potential for theft by terrorist individuals or groups and homeland-security issues.

JLS&A's devices are located in literally hundreds of facilities throughout the United States. Other firms' devices are also widely dispersed. Some of these facilities, like nuclear power plants and government installations, are relatively secure; others, like hospitals, blood banks and university laboratories, may not be. At any time, care of these sources requires the availability of space, the implementation of procedures for regular surveillance and inspection, and other ongoing costs, both to entities possessing them and to regulatory agencies. In times of heightened national security, when orphan sources can also become potential terrorist threats, the security cost of continued possession rises substantially. The cost of theft, diversion or other unauthorized misuse by terrorists - socially unthinkable - are enormous, and have not been addressed by IAEA (or NRC or DOT) in making the proposed revisions.

To make matters worse, as long as these devices are unshippable, no entity possessing them can conduct a final radiation survey and terminate its license. Every such licensee must remain indefinitely on NRC or Agreement State rolls. In the meantime, any closure of any facility containing such a device, or any sale or other transfer or conversion, becomes virtually impossible since the current licensee must either remain on the license for the device or transfer it to another qualified potential licensee. This not only greatly complicates normal real estate transactions but basically freezes any facility in its current use and ownership indefinitely.[38]

No attempt has been made here to monetize these costs. However, they are real, and substantial, and the rulemaking notices and draft Regulatory Assessments totally neglect them.

JLS&A is not in a position to conclude that the prospect of creation of potentially thousands of quite radioactive orphan sources around the country - which it believes is likely -as one collateral effect of the pending proposal constitutes a "major federal action significantly affecting the human environment" requiring a full-blown Environmental Impact Statement under the National Environmental Policy Act, 42 U.S.C. § 4331 et seq." What JLS&A does know is that

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[38] To illustrate the absurd complications of the orphan source issue, JLS&A is aware of one instance in which a bankruptcy creditor tried to seize a licensed radioactive device from an insolvent licensee and sell it as an asset of the bankrupt estate. JLS&A was asked to intervene, and did so by obtaining an administrative order, to prevent this from happening.

there has been no consideration of this issue, and that agencies issue rules without such consideration at their peril.]

Commenter No. 1090-0042: [The environmental costs of creation of hundreds or potentially thousands of new orphan sources are substantial. Hundreds of sites, some of them not secure, will have to safeguard no longer usable devices indefinitely, imposing costs on them and creating a risk of attack or security threats at readily identifiable sites from terrorist or other malevolent actors. Additional resource costs will be imposed on state and federal regulators, who will need to oversee the adequacy of security of these sites. And these costs will last indefinitely, until a removal mechanism is developed that is perceived as less costly than continuing storage. In the meantime, no facility in possession of one of these devices will ever be able to terminate its license. And sales or other transfers of any such facility will be greatly complicated by the presence of one of these devices, and shutdown will be impossible. Licensees will be unable to perform close-out radiation surveys or ever terminate a license.]

Commenter No. 1090-0042: [While transportation of these devices is regulated by NRC or DOT, depending on their configuration, their manufacture is regulated by the State of California, as an Agreement State, under its delegated authority to regulate source material. When manufacture of a device is completed. it is typically trucked to the customer's site. There, it is put into it’s operating configuration: specimen tray, drives, controls and instrumentation are added. There it stays, is listed in the Sealed Sources and Devices (SS&D) registry, and can be used, typically in a laboratory environment, without need for further transportation (barring relocation at the customer's instance or a need for service), for on the order of 30 years. At about that point it will need either to be re-sourced or decommissioned. It is then placed again into its shipping configuration and shipped again. Unless it has been relocated in the meantime, these are the only times a device is actually transported. This is the class of device which, if 2OWC containers are eliminated, will become untransportable.]

Commenter No. 1090-0042: [Transportation containers for these devices are designed within regulatory criteria, to meet the specific properties (size, weight, level of radioactivity, etc.) of the radioactive cargo they carry. Thus there have been numerous types of container designed and approved under the 1967 (or 1985 or 1996 or 2000) IAEA standards, but it is not the case that any such container can contain or safely transport just any cargo: container and cargo designs are matched (though individual devices do not have dedicated shipping containers). As noted above, under NRC and DOT definitions of "package" and "packaging", the radiological shielding and housing of the actual devices is included within the definitions of "packaging," thus tying transportation of devices tightly to the actual external containers designed for their transportation. As a result, eliminating 1967 Specification packagings would make it impossible to transport the types of radioactive sources for which they were designed, unless corresponding new containers are designed, tested and approved.]

Commenter No. 1090-0042: [The devices need to be refitted with fresh sources periodically and to be refurbished from time to time. They may also need relocation because of corporate reorganizations, openings of new facilities and closings of old ones, and the like. Eventually, they need to be decommissioned. All of these processes require shipment of radioactive materials. JLS&A performs these types of services not only for its own equipment but also for devices manufactured by various other firms now defunct; for some of them, JLS&A is the only firm in the country possessing all the drawings and other records necessary to make legal shipments. For instance, one obsolete type of device distributed under the aegis of the former

AEC is known to be located in at least five high schools and 28 colleges or universities around the country, awaiting shipment for decommissioning. Under the proposed regulations these would be orphaned. There are numerous other similar examples, which could be determined by license searches.]

Commenter No. 1090-0053: [Adding to the complexity, this company's devices—mostly irradiators and calibrators—come in a variety of models that contain integral shielding which is part of the “packaging.” If the NRC were not to permit flexible descriptions in its CoCs so as to account for variations in size, dimensions, weight etc. of the shielding on the devices, this company would find itself having to requalify its 1967-specification containers for not just two CoCs but literally dozens of them. They simply cannot afford this and would go out of business. One result would be that several hundreds of Type B sources would become, for all practical purposes, stranded and immovable from their current locations. Most of them—the ones that are now shipped in DOT-specification containers—could be transported, very expensively, in other existing containers: but for some, the only licensed containers capable of carrying them are the company’s containers, which would no longer be usable.]

Commenter No. 1090-0053: [Of primary concern to our Company is with regards to transporting iridium-192, used for industrial radiography. This radioisotope is an integral part of the oil and gas pipeline industry, commercial and military aircraft safety maintenance programs, and ship construction and repair. Our company is the only domestic commercial source of this radioisotope for industry. In the past, I^3 has transported Ir-192 in the GE-8500, a DOT Specification Package. This specific package has been used in the United States to transport up to 10,000 curies of Ir-192 in special form without incident for past 23 years. If the proposed regulations are adopted none of these containers will be available for use and there are no other containers available in the world that meet the proposed new requirements for domestic use within the United States.]

Commenter No. 1090-0041: [CORAR supports the proposal to accept the IAEA transitional requirements including the phase out of Type B specification packages and the termination of authorization of Safety Series 6 (1967) packages. Specification packages and Safety Series 6 (1967) packages have not been designed and constructed according to standards where their continued use would be consistent with the intent of the regulations.]

Commenter No. 1090-0011: [There needs to be an effective date applied to some or all of these rule changes to grandfather existing approved transport cask designs. Without that, all Part 71 CoC holders are subject to backfit for compliance with no commensurate safety benefit. As an example, the A_1 and A_2 values in the rule are used in the HI-STAR/HI-STORM containment and confinement analyses. Many of these values are changing and would require CoC holders to re-perform these analyses, update the affected SARs, and depending on the results, either submit the new analysis as part of CoC amendment requests (three, in Holtec’s case) or perform the accompanying 72.48 and 71.175 evaluations and update the SARs accordingly. This creates an unnecessary administrative burden on CoC holders with no safety benefit. This is just one example. The NRC needs to perform a comprehensive evaluation of what impact the rule changes will have on existing dual-purpose certificate holders if a grandfather clause is not included in the rule.]

Commenter No. 1090-0042: [Both NRC and DOT have misassessed the impact of their proposals on small entities protected by the Regulatory Flexibility Act, 5 U.S.C. § 601 et seq.

NRC certifies that there will be no "substantial economic impact on a substantial number of small entities, on the basis that:

- This proposed rule affects NRC licensees, including operators of nuclear power plants, who transport or deliver to a carrier for transport, relatively large quantities of radioactive material in a single package. These companies do not generally fall within the scope of the definition of "small entities" set forth in the Regulatory Flexibility Act or the size standards adopted by the NRC (10 CFR 2.810).

67 Fed. Reg. 21442. The NRC's observation is absolutely true of nuclear power plant owners and operators and sometimes true of shipping companies. However, JLS&A is a small entity within the NRC's criteria. So are numerous others of the entities that manufacture or actually transport devices affected by the proposal. Whenever their absolute number, JLS&A believes that they represent a substantial portion, if not the majority, of the entities in this business. Thus, JLS&A believes, the provisions of the Regulatory Flexibility Act are triggered. In any event, the NRC's characterization of nuclear power plant operators as the typical type of entity affected by the proposal under discussion is incomplete: in addition to entities like JLS&A, they include hospitals, research facilities, blood banks, colleges and the like, numerous of which all within the size or income categories of small entities.

DOT, by contrast. concedes that a large number of entities, a potentially significant number of them small, will be affected by the proposed rule, but asserts that imposing international uniformity will offset, for many of them, a higher cost of complying with dual systems of regulation. DOT also asserts that "the proposed phase-in period of two years following the effective date of the final rule for continued use of currently authorized packagings should provide for a smooth transition to the NRC approval process." 67 Fed. Reg. 21345 col. 3.

DOT’s dual-regulation argument, while plausible in the abstract, is not persuasive as to the continuation of use, or not, of an existing class of container for domestic shipments. DOT's argument ignores the fact that in the United States *(*far more than in Europe), a major proportion of shipments of radioactive materials never cross national borders. For numerous shippers, there simply is no potential for dual-regulation tension. Finally, for reasons set out above, JLS&A believes that the proposed two year transition period is not adequate.

In short, for different reasons than those relating to the NRC, JLS&A believes that neither NRC nor DOT, for different reasons, can make the required Regulatory Flexibility Act certification on the rule as proposed.]

Commenter No. 1090-0042: [As outlined in more detail below, virtually all of the devices manufactured or serviced by JLS&A use sources that contain Type B quantities of radioactive material. Some are shipped in packagings approved under a Certificates of Compliance issued by NRC. The vast majority of devices, however, are designed to qualify under DOT regulations as DOT Type 7A packages which, when fitted with a metal jacket and contained in a DOT Specification 2OWC overpack, may be used to transport Type B quantities of radioactive material in special form.]

Commenter No. 1090-0042: [There are two types of outer containers, or "overpacks," both designed to 1967 Specifications, used by JLS&A for shipment of these devices: those licensed pursuant to COCs from the NRC, and those designed pursuant to DOT Specification packages. JLS&A owns and uses two overpacks manufactured pursuant to COC 6280[39] and some 15 DOT Specification 20WC overpacks to ship these devices. These containers are made of reinforced plywood, generally with a steel outer casing, in the shape of a right cylinder. Typical containers stand about six to seven feet high and four to five feet in diameter. Empty, these overpacks weigh up to 2000 pounds apiece. Loaded with a device, the DOT 20WCs weigh up to 6000 pounds; NRC COC containers weigh up to slightly over 10,000 pounds. The principal basis for difference in size and weight is a difference in radiological capacity: the contents of 20WCs are limited by DOT regulation to 100 watts of decay heat output; the COC containers have container-specific restrictions. Neither of these container types is designed to transport irradiated reactor fuel.]

Commenter No. 1090-0042: [First, the 1967-Specification containers have a long and excellent safety record.]

Grandfathering Previously Approved Packages: Grandfathering is a serious mistake and should be entirely disallowed by NRC. Past container testing has been disgracefully lax. At best, it will be a number of years before appreciable amounts of "spent" fuel can be transported for more permanent disposition, even if Yucca Mountain is ultimately licensed by NRC. This gives a substantial window of time for the design, development, and prooftesting of new, better shipping casks, if HLW is to be moved. However, licensees should not be given a three-year grace period in which to continue to use casks based on ancient 1967 requirements. Moreover, 1985 safety testing criteria are also woefully outdated. More stringent up-to-date testing and performance levels must be adopted by the NRC in light of contemporary security concerns. HLW movement should be kept to an absolute minimum until the quality and durability of casks have been substantially improved to meet contemporary needs for greater safety. [Commenter No. 1090 - 0128]

I. Issue 9 - Changed to Various Definitions
   i. Overall Impact (including cost-benefit data)
   ii. NRC Proposed Position

Qualitative

Commenter No. 1090-0052: [The exclusion of this definition could lead to packages meeting one of the standards (the TS-R-1 requirements or NRC) and there is no clear case for excluding the definition.

Westinghouse is currently developing a number of packages to be used in international shipments. The safety case will be built around defining both the confinement and containment system, which may be different. This will lead to different evaluations if the NRC does not adopt and recognize this *confinement* definition.]

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[39] JLS&A has committed to the NRC, for reasons unrelated to this rulemaking, not to use any of its COC containers further until they have either been qualified under the TS-R- 1 standards or exempted from them. JLS&A is the certificated owner of two COC designs in addition to COC 6280. JLS&A owns all of the overpacks manufactured to these COCs.

Commenter No. 1090-0052: [No definition is provided for this term and Table 16-1 indicates that the NRC believes that this is not necessary. Westinghouse does not agree with this position. Without a clear definition of the term it is possible to base a consignment on the material described in a single shipping manifest and to have multiple shipping manifests provided to the carrier for transport at one time. While this problem has been eliminated from consideration for the shipment of fissile exempt materials under the proposed rule, the consignment issue remains with the exempt quantity provisions of proposed Table A-2. Westinghouse recommends that the NRC adopt the definition of "consignment" included in the DOT proposed rule.]

Commenter No. 1090-0052: [It is noted that the NRC Part 71 Subpart H requirements are different than those defined in TS-R-1 paragraph 232. There will, therefore be additional procedures required to ensure consistency with both requirements for international transports.]

Commenter No. 1090-0052: [The exclusion of this definition could lead to inconsistencies in licensing packages for international transports.]

Commenter No. 1090-0052: [The proposed definition is based on the definition provided in 10CFR110.2. Westinghouse believes that this is an inappropriate definition for the purpose of nuclear criticality safety. The definition provided in paragraph 110.2 is equivalent to saying that "deuterium" includes any material enriched by more than about 30% over the natural ratio of deuterium atoms to hydrogen atoms. Westinghouse believes that such a definition is overly conservative for purposes of nuclear criticality safety. The NRC should provide a definition of deuterium that is based on a ratio of deuterium atoms to hydrogen atoms that is important to nuclear criticality safety.]

Commenter No. 1090-0052: [The proposed definition is based on the definition provided in 10CFR110.2. Westinghouse believes that this is an inappropriate definition for the purpose of nuclear criticality safety. The definition provided in paragraph 110.2 is very stringent with respect to the purity of the graphite (less than 5 ppm boron equivalent and a density greater than 1.5 g/cc). While such nuclear grade graphite may be appropriately regulated for purposes of export, this has no relationship to the needs to control graphite content for the purposes of nuclear criticality safety. Westinghouse believes that the proposed definition may not be conservative enough for the purpose of nuclear criticality safety when considering higher concentrations of fissile material that are equivalently present in natural uranium. While such pure graphite may be needed to achieve a self-sustaining chain reaction with natural uranium, it would not be needed for higher uranium enrichments. The NRC should provide a definition of graphite that is based criteria that are important to nuclear criticality safety.]

Commenter No. 1090-0052: [The definitions for these terms differ between those provided in the NRC and DOT proposed rules. In some instances the differences are important. For example, 1) for LSA-I (iv) the two definitions are incompatible, and 2) for LSA-III the DOT includes the parenthetical phrase "excluding powders", whereas the NRC definition does not include such a limitation. While other less serious differences also exist, there is no reason why any differences should exist. Westinghouse recommends that the definition for the various LSA materials be consistent between the agencies.]

J. Issue 10 - Crush Test for Fissile Materials Package Design

i. Overall Impact (including cost-benefit data)

ii. Issue-Specific Discussion

Qualitative

Crush Test for Fissile Material Package Design: This commenter had encountered (and avoided by minutes being beneath) a boulder the width of the highway in the Wyoming Wind River Range some years ago. No vehicle or container could have withstood the impact of that boulder's fall from several hundred feet above. The experience was not a theoretical highly improbable event. Crush testing must be mandatory, with the cost borne by licensee or user. [Commenter No. 1090 - 0128]

iii. NRC Proposed Position

Qualitative

Commenter No. 1090-0051: [The Alliance for Nuclear Accountability would like to point out that in addition to crush and drop testing, additional testing of containers is needed. For example, Neither the DT-22 not the 9975 have been sufficiently tested against fire. Testing at 1475 degrees Fahrenheit for 30 minutes excludes more than 20 materials routinely transported on highways that burn more than twice this temperature. The heat test should be made more stringent and realistic than required under current regulations.]

Commenter No. 1090-0052: [The NRC position is to demand both tests, which are essentially for the same accident conditions, and it is unreasonable to assume that the package could be subject to both a crush condition and a drop condition under the same accident scenario.

However, it is not unreasonable to have both tests to ascertain the most damaging condition but if they are on different packages. To carry out the two tests on the same package is a double drop test and beyond the considered accident scenarios. This is a more damaging set of tests than that required for other packages and is essentially a double 9 meters drop test, which is not something demanded of other packages on the same item.]

Appendix A of the Modal Study (9), relates the assessment of a severe derailment at Livingston Louisiana on September 28, 1982. The Modal Study (10) relates a rail incident involving extensive crushing damage to railway cars. The analysis in the Modal Study indicates that:

> under 4.1.10 Evidence of Bending/Deformation of Support Members the assessment is:
>
> "36 cars destroyed by crushing impacts during derailment or by post accident fires" (11)

Many other railway accidents since the Livingston, LA derailment have involved crush loading or cars stacked on top of each other. The University of Illinois conducted an analysis of Federal Railroad Administration (FRA) railroad accident statistics and found that over the past 10 years, 25% of mainline derailments occurred at speeds greater than 39 mph. Of these 72% involve more than one car, and 45% involve more than 10 cars. The large number (and consequent mass) of cars (as well as other SNF casks) involved, and the high speed of derailments, indicates that there is substantial kinetic energy involved and that major pile-ups of railcars can occur. It is thereby necessary to understand the performance of SNF casks under crush-loading conditions such as might occur in these types of accidents. [Commenter No. 1090 - 0137]

K. Issue 11 - Fissile Material Package Design for Transport by Aircraft
   i. Overall Impact (including cost-benefit data)
   ii. NRC Proposed Position

L. Issue 12 - Special Package Authorization
   i. Overall Impact
   ii. Issue-Specific Discussion

Qualitative

Commenter No. 1090-0035: [The NNPP routinely demonstrates that all shipments, including reactor vessels and larger reactor compartments are made in compliance with 10CFR7l. Therefore, relaxation of requirements applicable to large packages could potentially reduce the cost of these shipments. However, the proposed modification states that a special package authorization may be approved only for “one time shipments". Since NNPP makes multiple shipments of reactor vessels and reactor compartment that are of the same nominal design (i.e., a particular submarine class), this restriction would require recertification of these packages for each shipment. To avoid unnecessary, repetitious certification requests, NNPP considers that this restriction should be relaxed to allow a limited number of shipments.]

Commenter No. 1090-0053: [*NRC Request for Information:* What additional limitations, if any, should apply to the conditions under which an applicant could apply for a package authorization?

Industry Response: No additional limitations are required. The few packages that have been authorized have moved without incident and without undue risk to the public, workers or the environment. The special package approval process is working under the current requirements.]

Special Package Approval: We urge the NRC not to offer "special conditions" that allow a licensee or shipper or other user to request relief from regulations. The staff has already been exempting and deregulating on case-by-case bases for many years, resulting in substantial amounts of deregulated materials and wastes in commercial circulation and uses without the knowledge or consent to additive doses on the part of individuals who may be exposed, and with no requirement or effort by the responsible agencies to study possible negative impacts of those exemptions and releases. [Commenter No. 1090 - 0128]

   iii. NRC Proposed Position

M. Issue 13 - Expansion of Part 71 Quality Assurance Requirements to Certificate of Compliance (CoC) Holders
   i. Overall Impact
   ii. NRC Proposed Position

N. Issue 14 - Adoption of American Society of Mechanical Engineers (ASME) Code
   i. Overall Impact
   ii. NRC Proposed Position

O. Issue 15 - Change Authority for Dual-Purpose Package Certificate Holders

Comments received will be incorporated into a final rule

P. Issue 16 - Fissile Material Exemptions and General License Provisions

i. Overall Impact

Qualitative

Given the manner in which all shipments are made under § 71.1 *5(a)(l)* and (a)(3) of the current regulations, there are insufficient data in NUREG/CR-5342 to support changing these sections of the regulations. The assumptions made in this analysis appear based on theoretical scenarios that do not reflect current shipping practices. The NRC may wish to re-examine its data analysis to identify whether this change is appropriate from both a cost and safety perspective.

While DOE recognizes the necessity for increased security, the proposed controls appear disproportionate to the actual risk posed by typical shipments. If the intent of the controls is to address concerns with mass conveyance limits, then a balance must be made with the operational aspects of transportation. Data in NUREG/CR-5342 do not demonstrate that the shipments currently made under these sections pose any criticality concern or require the additional controls proposed. DOE's shipping history for these materials has been exemplary and there have been no criticality concerns associated with them.

DOE uses the volume exception provisions extensively and has done so for decades without incident. Typical DOE shipments made under these provisions include contaminated laundry shipments, environmental sample shipments, and low-level waste shipments. The proposed regulations would result in DOE being unable to ship laundry and environmental sample shipments in their current packaging configuration (e.g., fiberboard boxes, poly bottles in plastic coolers, canvas bags, metal boxes and drums, and railcars).

Elimination of these provisions would pose an undue and costly burden to DOE cleanup operations, without a demonstrated increase in safety. The economic impact to DOE sites would be significant. DOE's Oak Ridge facility alone runs weekly laundry shipments and as many as ten environmental sample shipments daily. The current provision for 15 grams per package should be retained for domestic shipments. [Commenter No. 1090 - 0171]

ii. NRC Proposed Position

Qualitative

Commenter No. 1090-0035: [§ 71.15 (a) identifies that the 15 gram exception is now accompanied by a restriction that iron must be present in a 200:1 ratio by mass. Thus, a fissile excepted package with 15 grams 235U must also contain 3000 grams of iron to be exempted. The regulation is ambiguous as to whether iron in the packaging (e.g., internal structure) may be used to meet this requirement and should be clarified.]

Comment No. 1090-0040: [These changes impact a significant number of shipments (e.g., contaminated laundry, environmental samples, bulk packaged low level waste). Typical fissile mass per package (and in some cases conveyance) ranges from micrograms to 15 g. These shipments are vital to meeting the DOE missions of research and environmental cleanup. The Commission may wish to examine again its data analysis to identify whether this change is appropriate from both a cost and safety basis. The shipping history for these materials has been exemplary and there are no indications of legitimate criticality concerns associated with them.]

Commenter No. 1090-0040: [DOE makes extensive use of the fissile exempt section of the regulations. Typical shipments made under these provisions include contaminated laundry shipments, environmental sample shipments and low-level waste shipments. Typical packaging configurations include: fiberboard boxes, poly bottles in plastic coolers, canvas bags, metal boxes and drums and railcars. Radioactive contents includes solids and liquids, and sometimes special form sources.]

Commenter No. 1090-0040: [The economic impact will be significant. In Oak Ridge alone, an average of 10 environmental shipments are made daily and laundry shipments run weekly. These types of shipments have been made safely for decades without criticality incidence. The current provision for 15 grams/package should be retained for domestic shipments until such time as DOT and NRC can demonstrate that this is an unsafe configuration for these shipments.]

Commenter No. 1090-0052: [While the proposed changes eliminate some of the restrictions that were incorporated in the emergency rule they do not provide for the ability to ship large volumes of decommissioning waste in an effective manner.

Under the proposed rules, 71.15(b) allows the shipment of material as fissile exempt provide a mass ratio of 2000:1 is applicable but places the additional requirement that the package contain less than 350 grams of fissile material. For shipments of enriched uranium contaminated decommissioning waste, this effectively limits the package volume to less than one cubic meter. Such small package volume limits are unrealistic to meet the needs for decommissioning efforts. Furthermore, this mass ratio criterion would limit the maximum concentration for low enriched uranium to about % of the waste acceptance criteria for the EnviroCare disposal site.

While larger volume shipments are possible if the enriched uranium concentration is greater than the minimum mass ratio limit, experience has shown that the package limit of the proposed rule will prohibit large bulk shipments as fissile exempt material. For example, for low enriched uranium (i.e. 5% U-235) contaminated soil where the average uranium concentration is 300 pCi/g, a bulk shipment in a railroad gondola car will exceed the 350 gram fissile package limit. Such considerations would continue to place serious limitations on the planning for the shipment of decommissioning waste materials containing enriched uranium contamination. This limitation appears to be primarily due to the fact that this portion of the proposed rule has eliminated the need to have limitations of the content of lead, beryllium, graphite and hydrogenous material enriched in deuterium.

Note also that the proposed changes for fissile exempt material can actually be more restrictive for bulk containers, such as a rail car, under the proposed rule than under the existing emergency rule. For bulk shipments, in a rail car, of enriched uranium contaminated waste, the current rules would limit the shipment to 400 grams of U-235 (the consignment limit), whereas the proposed rule would limit the shipment to 350 grams of U-235 (the package limit).

In the situation for decommissioning waste where the fissile material is dispersed in a large mass of other materials, the concept of a ratio criterion is simple to implement. The added restriction of the package mass limit however effectively limits the allowable volume of the package and would therefore not allow the efficient use of bulk packaging. Thus the proposed rules do not provide for the efficient shipment of such wastes that are anticipated in decommissioning projects.]

Commenter No. 1090-0053: [*Industry Position:* Industry supports the concept of exemptions for fissile material shipments under specific conditions. The NRC's proposal in § 71.15 is overly conservative and results in a reduction in the limits of fissile material content without justification. As discussed in our covering letter, the proposed rule combines the use of a concentration limit with a mass limit. This approach is overly conservative, as either means of criticality control would assure the safety of the package.

§ 71.15 (a) *'Exemptions from classification as fissile material'* provides a blanket exemption from fissile shipment requirements for less than 15 grams of fissile material if shipped in, or with, combustible materials. Our concern is the impact on a shipment of resin or other materials that has small quantities (>15g) of fissile material. Resin is combustible, and there may not be enough iron to meet the new requirements. Thus, there are no exemptions for material that obviously could not go critical. As 350 grams or less of fissile material is criticality safe regardless of the moderation or configuration, in lieu of 15 grams the limitation should be 350 grams per conveyance.]

Comment No. 1090-0052: [The proposed adoption of the fissile exemptions as worded is of considerable concern to Westinghouse. Paragraph 672 of TS-R-1 provides for fissile exempt materials that is the system adopted by the international community. The proposed rules provide for a completely different approach to fissile exempt materials. This difference will complicate the transport in international trade of these materials. Unless the proposed rule also permits shipments of fissile exempt materials in accordance with the provisions of TS-R-1, a shipper will be required to meet both regulations for international shipments with the attendant confusion and increased probability of nonconformance.]

Commenter No. 1090-0052: [The rule implies that “incident to transport” applies to port operations (DoT consider port layovers to be “incident to transport”). There is no time limit defined. The transfer of cargo from vessel to truck or the time required to get customs clearance would come within this definition. Under the proposed changes for 71.59, a shipper would be restricted to accumulations of fissile material up to a total of a CSI of 50 for transport if the storage incident to transport occurred. This requirement would essentially eliminate the ability to transport under exclusive use conditions where the CSI limit is higher.

The industry is losing many of the liner services, which previously were willing to carry radioactive material. There is a significant increase in the reliance on charter vessels to service the nuclear industry for the transport of radioactive materials. This rule, limiting the CSI to 50 for operations “incident to transport” would reduce the cargo allowed on a vessel and therefore both increase the number of transports required and the cost by a factor of two or three.

It seems inappropriate that the NRC would wish to increase the number of shipments but this is what the proposed rule would do.]

Q. Issue 17 - Double Containment of Plutonium (PRM-71-12)
   i. Overall Impact
   ii. Issue-Specific Discussion

Qualitative

Commenter No. 1090-0053: [*NRC Request for Information:* What cost or benefit impacts would arise from removal of the double containment requirement for plutonium?

Industry Response: The principal benefit of removing the double containment requirement would be a reduction in exposure to the workers. Currently the double containment requires that the worker spend more time packaging, inspecting the loaded package and certifying it meets the double containment requirements. By removing this requirement workers will be less exposed and, therefore, more likely to receive lower doses. It would also result in a lower packing cost from the design, manufacturing and operational aspects compared to the current double containment package.]

Double Containment of Plutoniurn (PRM-71-12): ECNP incorporates by reference the ECNP comments submitted in response to 63 FR 8362, Docket No. PRM-71-12 to amend Part 71.63(b). The only benefits from eliminating double containment for plutonium would accrue to the DOE, to contractors, licensees, and shippers in the form of cost savings. It is absolutely unconscionable for the NRC to relax packaging and shipping requirements for plutonium in any form. With the dismantling of nuclear weapons and the evident intent of the federal government to proceed with MOX fuel, larger and larger amounts of plutonium may be on the roads, railroads, or possibly barges - in a time of national security threats. Few terror threats could exceed the hazard of an attack on plutonium in transit. Safety of containerization must be maximized, not relaxed, no matter how burdensome either the government, contractor, or others may consider it to be. Shipment of plutonium in liquid form should be prohibited altogether.* To reduce or eliminate any safety requirements whatsoever for the packaging, handling, and shipment of plutonium would be actionably arbitrary and capricious, and contrary to the mandates of applicable laws, including the Atomic Energy Act and National Environmental Policy Act. Double containment must be required for all plutonium packaging and transporting. [Commenter No. 1090 - 0128]

iii. NRC Proposed Position

Qualitative

Commenter No. 0028: [I also ask that NRC reject the proposal to allow plutonium to be shipped in single shelled containers, when double shells have been required for 30 years. Thousands of plutonium shipments are projected to go to the WIPP dump in New Mexico. The original WIPP shipping containers. TRUPACT-I were rejected because they only had single containment. Current and proposed WIPP containers have double containment. Reducing the required containment on plutonium shipments increases public exposure risk and the release risk from containers. The Environmental Evaluation Group at WIPP has documented that double containers are significantly safer than single. I oppose any weakened or indefensible substitutions in cask design requirements.]

Managing the transportation of transuranic (TRU) waste from the DOE facilities to the Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico is the joint responsibility of federal, state, local, and tribal governments. For more than 10 years, the Western Governors Association, which consists of 21 western states and territories, has assisted its member states in the development and coordination of a WIPP transportation program that would be acceptable to the public. At the heart of this WIPP transport safety program is the TRU PACT II double containment packaging. The public was led to believe that the extra barrier provided by double containment along with adoption of the other transportation safety protocols would lead to safe shipments. We are concerned that removal of the double containment requirement could seriously erode public confidence in the WIPP transportation safety program.

In the two and a half years since WIPP opened, the WIPP transport safety protocols have been fully implemented and are now accepted by most of the people along shipment corridors. We believe strict adherence to these protocols has not only resulted in the safe and uneventful transportation of more than 1.000 truckloads of TRU waste to WIPP, but also fostered public confidence as welt. It is our goal to ensure that record will continue. If the rule on double containment is relaxed, this safety record could be jeopardized unless the NRC obtains scientific evidence that demonstrates beyond a reasonable doubt that single containment is as safe as double containment. The NRC should also weigh the potential damage to public confidence in the WIPP shipments, if the double containment requirements are relaxed. [Commenter No. 1090 - 0130]

Commenter No. 1090-0051: [The Alliance for Nuclear Accountability also firmly opposes the proposal to move from double to single-shell containers. This move would undo 30 years of regulatory practice without demonstrating improved safety to the public. The public not only believes that double-shelled containers are safer than single-shelled containers, the NRC and DOE's own data show this to be true. Risk assessment models developed by the Environmental Evaluation Group in 1986, and approved by the DOE and NRC, showed that double-shelled containers would dramatically reduce latent cancer fatalities in case of a serious accident. As a result, the originally proposed WIPP shipping container (TRUPACT-I) was rejected in significant part because it provided only single-shelled containment.]

The US. Department of Energy (DOE), which is a major shipper of plutonium in excess of 74 TBq, has made commitments to the corridor states for shipments to the Waste Isolation Pilot Plant in New Mexico. One of those commitments is the use of the TRUPACT II shipping containers, which use a double containment system. Although it is possible that DOE could continue to use the TRUPACT II without the double containment, this action would constitute a significant change in the transportation system and would not be in keeping with the commitments made to the corridor states and other stakeholder. Given the extensive training and public information activities the states and DOE have conducted, such a change would engender its own costs stemming from the need to prepare new information materials and conduct outreach to the public, elected officials, arid emergency responders along the shipping corridors. [Commenter No. 1090 - 0136]

The proposed rule change to remove the double containment requirement is inconsistent with our nation's commitment to reducing vulnerabilities to emerging terrorist threats. Given the heightened awareness of possible terrorist attacks, widespread public fear of anything "nuclear" or "radioactive", and public concern over the safety of nuclear waste shipments, we believe that the NRC should not relax the double containment requirement until the NRC completes a valid safety assessment comparing the vulnerability of single versus double containment to acts of terrorism. A recent National Academy of Sciences study to develop recommendations for making the nation safer against terrorism concluded that the NRC should 'Tighten regulations for obtaining and possessing radiological sources that could be used in terrorist attacks, as well as requirements for securing and tracking these sources." Clearly, the trend post-September 11 is toward stricter, rather than more relaxed, safety standards for radioactive materials. [Commenter No. 1090 - 0130]

The original rationale for establishing the double containment requirement in 1974 is still valid. In 1974, the Atomic Energy Commission (AEC) imposed the double containment requirement, when large numbers of plutonium shipments were anticipated from commercial reprocessing of spent nuclear fuel. The AEC's regulatory concern was based on the increased possibility of human error combined with the expected increase in the number of shipments, and that this would yield an increased probability of leakage during shipment. Although commercial reprocessing was abandoned in the United States in the late 1970s, a large increase in plutonium shipments is once again anticipated from the United States Department of Energy's (DOE) programs for facilities' clean-up, waste management, R & D, and weapons dismantlement. With such an increase in shipments, the potential for human error (e.g., improperly assembled and dosed packages) and transport incidents would similarly be expected to increase. [Commenter No. 1090 - 0130]

Commenter No. 1090-0051: [The Alliance for Nuclear Accountability is alarmed that DOT and NRC are seeking to approve single-shelled containers for wastes transport at a time when the risks of contamination are greatly increasing due to the threat of terrorist attack and the much higher volume of transports anticipated in coming years. If anything, standards should be reevaluated with the purpose of increasing public safety by strengthening these standards, not weakening them. ANA expects that cost benefit analyses of this proposal would favor double-shelled containers given the enormous added costs of containment and cleanup, as well as the potential need for health care treatment and monitoring were the container to rupture and spread contamination.]

Although the NRC provides a thorough and enlightening review of the history of § 71.63(b), the committee feels strongly that the Commission should consider the reaction of the public to what will undoubtedly be perceived as a scaling back of measures that ensure the safety of shipments. The NRC must recognize that this is a time of heightened public awareness of and concern over shipment safety, due both to the events of September 11 and to the recent decision to allow DOE to proceed with a license application for a repository at Yucca Mountain. By proposing to eliminate the double-containment requirement, the Commission runs the risk of undermining the public's confidence in the regulations that are intended to ensure the safety of radioactive materials shipments. [Commenter No. 1090 - 0136]

The NRC justifies its recommendation for eliminating the double containment requirement by arguing that the worldwide performance record over 40 years of Type B packages demonstrates that a single containment barrier is adequate." However, this record only reflects accidental releases of plutonium, not potential deliberate acts of aggression or terrorism. As no new risk related studies were cited in the proposed rulemaking, it appears that none have been conducted on this issue.[40] Further, the petitioner who originally proposed the rule change argues that single containers would be safer for the personnel who currently must handle the inner container. Adopting a single containment requirement may, in effect, just be shifting the probabilities of risk from the package handlers to the general public. However, until studies are done, such a shift cannot be justified. [Commenter No. 1090 - 0130]

Commenter No. 1090-0040: [The Department of Energy supports the proposed removal of the requirement for "double containment" of plutonium from § 71.63. A single containment barrier is adequate for Type B packages containing more than 20 Curies of solid form plutonium. The Department of Energy conducted an in depth analysis of the current double containment rule and identified the associated impact on worker health due to additional radiation exposure as well as projected increased operational costs. This proposed revision will reduce radiation exposure to personnel who open and close packages and will reduce the cost of packaging and its associated hardware. The excellent safety record of single containment Type B packages in 40 years of shipments, confirmed by DOE and NRC safety studies, as well as improved QA and analysis capability developed in that period, provide reasonable assurance that this revision to the Type B packaging standards for plutonium will provide adequate protection to public health, safety, and the environment during transport.]

Commenter No 1090-0197: [The Environmental Evaluation Group (EEG) stated that the conclusion that single containment will decrease radiation doses is incorrect for WIPP shipments. EEG contends that radiation doses would increase to both workers and the general public. EEG also stated that while an 8-13% volume reduction due to weight restrictions caused by double containment is not trivial, the benefits from reducing this weight penalty needs to be balanced against the resulting increase in radiation doses, the increased likelihood of a release in the event of a severe accident, and the increased cost of certifying a new package. EEG stated that if Section 71.63(b) is deleted, there will very likely be some use of single-contained packages for future WIPP shipments. EEG recommended that both 71.63(a) and 71.63(b) be retained but that the limit be expressed as 0.74 TBq (20 Ci) for the total of all actinides with A_2 values equal to or less than $1.0x10^{-3}$ TBq ($2.7x10^{-2}$ Ci). EEG cited the economic, shipping, and public confidence aspects of a severe accident release as the primary arguments in support of retaining double containment.]

R. Issue 18 - Contamination Limits as Applied to Spent Fuel and High Level Waste (HLW) Packages
   i. Overall Impact
   ii. Issue-Specific Discussion

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[40] It is worth noting that in June [986 the Environmental Evaluation Group (EEG) issued a report entitled "EEG-33: Adequacy of TRUPACT-I Design for Transporting Contact-Handled Transuranic Waste to WIP?." On page –iv- of this document, EEG concluded: A *principal advantage of a TRUPACT with double containment is the estimated decrease from 12 to .02 in the number of accidents involving radionuclide releases during the WIPP Project. Even minor accidents involving little public radiation exposure are costly to monitor and clean up and can decrease public confidence in the safety of radioacrive material shipments. An additional advantage of double containment is the extra protection it is expected to provide in the event ofa low probability (0.1-1%) thigh consequence accident. These very severe accidents could result in up to 10-30 latent cancer fatalities with the present design. Double containment is estimated to reduce this by at least 60% to 80%.*

Qualitative

Commenter No. 1090-0053: [*NRC Request for Information:* The NRC seeks information regarding the application of the regulatory limits for removable contamination on the external surfaces of packages used for spent fuel shipments. This information will be most helpful if respondents also indicate the cask design used and whether or not the cask is fitted with a protective cover prior to immersion in the spent fuel pool. Specifically, for previous spent fuel shipments, information is sought on: (1) the removable contamination level on the cask surface after the cask has been loaded, removed from the spent fuel pool, and dried; (2) the dose attributable to any decontamination efforts, including external dose from cask and facility radiation fields and internal dose from airborne radioactivity in the cask handling/loading areas; (3) the removable contamination level on the cask surface after decontamination efforts and before shipment; and (4) the removable contamination levels on the cask surface upon receipt at the destination facility.

Industry Response: Industry has not experienced problems with decontamination and dose attributable to the handling and transport of spent fuel or storage casks. There is no reason to seek any special dose consideration or reductions in this area. The industry did experience some of the weeping issues in the early 90's but through programs working with the manufacturers of casks and use of improved cleaning agents we have eliminated this condition.]

iii. NRC Proposed Position

S. Issue 19 - Modifications of Event Reporting Requirements
  i. Overall Impact
  ii. NRC Proposed Position

Qualitative

Modifications of Event Reporting Requirements: The NRC should not allow any relaxation of reporting requirements but should, instead, increase the manifesting requirements and, in particular, should greatly increase enforcement. There can be no excuse for a 60-day - or a 30-day - delay in filing a report on any event involving the malperformance of a package or container. While we would concur that a certificate holder should be required to have input with a licensee in order to determine if there were design defects, equally important would be possible production defects. We support the NRC's concern that there should be direction provided about the expected contents of a report. However, the requirement should not be so restrictive or so "unambiguous" as to preclude identification of possible multiple causes of package or container malfunction. If a performance problem arises while a package or container is in use and "on the mad" there should be immediate notification of the NRC staff by the responsible party or parties (licensee, certificate holder, driver, guard, other accompaniment). We suggest a two-stage reporting process: initial, short-term while the incident or observation is fresh within a few days (c. one week) and a final detailed report within no more than one month, unless extension is needed to complete investigation. Timeliness of reporting should serve the needs of the staff - and public safety - not of convenience for the licensee. The locus for submitting reports (Document Control Desk) seems rather bureaucratic, eccentric to the agency division with primary need to know NMSS). For the reasons given, ECNP and NECNP oppose the NRC's Proposed Position. [Commenter No. 1090 - 0128]

III.	DOT-Related Issues

IV.	Other Issues

Qualitative

The Department is also promoting the use of mixed oxide (MOX) fuels for the nation's remaining commercial reactors, an action that would greatly increase the numbers of plutonium shipments through densely populated areas - from DOE storage sites to fuel fabrication facilities, to reactors, and eventually to some more permanent "disposal" facility. [Commenter No. 1090 - 0128]

Potential Congressional action may soon require some tens of thousands of shipments of "spent" fuel rods to begin to be transported a non-existent interim storage facility at the Yucca Mountain site or other location, plus international shipments of "spent" fuel. [Commenter No. 1090 - 0128]

List of Commenters			
New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
Chicago, Illinois Public Meeting (Afternoon and Evening Session; June 4, 2002)			
1	CA-001, CE-001, RM-002, RA-001, 1090-0037, 1090-0146	Ms. Diane D'Arrigo	Nuclear Information and Resource Service
2	CA-002	Mr. David Kraft	Nuclear Energy Information Service
3	CA-003, 1090-0041	Mr. Mark Doruff	Council on Radionuclides and Radio-pharmaceuticals
4	CA-004	Ms. Sidney Baiman	Nuclear Energy Information Service
5	CA-005, 1090-0004	Ms. Joy Reese	N/A
6	CA-006	Ms. Margaret Nagel	Variety of Chicago organizations including Chicago Media Watch and Chicago Peace Response
7	CA-007	Mr. Manny Tuazon	Consumers Energy
8	CA-008	Ms. Debbie Musiker	Lake Michigan Federation
9	CA-009	Mr. Paul Gaynor	Environmental Law and Policy Center of the Midwest
Rockville, Maryland Public Meeting (Morning Session; June 24, 2002)			
10	RM-001, 1090-0034	Mr. Marc-Andre Charette	MDS Nordion

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New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
11	RM-003	Dr. M. Elizabeth Darrough	United States Enrichment Corporation
12	RM-004	Ms. Elizabeth Goldwasser	United States Enrichment Corporation
13	RM-005, RA-005	Mr. Robert Halstead	Nevada Agency for Nuclear Projects
14	RM-006, RA-004, 1090-0053	Mr. Felix Killar, Jr.	Nuclear Energy Institute
15	RM-007, RA-008	Mr. William Lake	U.S. Department of Energy
16	RM-008, RA-007, 1090-0138	Ms. Melissa Mann	Transport Logistics International
17	RM-009, RA-009	Mr. Robert Owen	Ohio Department of Health
18	RM-010, RA-012, 1090-0142	Mr. David Ritter	Public Citizen - Critical Mass Energy and Environment Program
19	RM-011	Mr. Mark Rogers	Airline Pilots Association
20	RM-012, RA-002, 1090-0049	Mr. Charles Simmons	Kilpatrick Stockton
21	RM-013	Mr. Fred Dilger	Clark County, Nevada
22	RM-014, RA-010	Ms. Eileen Supko	Energy Resource International
23	RM-015	Dr. Judith Johnsrud	Sierra Club Environment Coalition
24	RM-016, RA-003	Mr. Don Erwin	Hunton & Williams (Representing J.L Shepherd)

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New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
Rockville, Maryland Public Meeting (Afternoon Session; June 24, 2002)			
25	RA-006, 1090-0011	Mr. Brian Gutherman	Holtech International
26	RA-011	Mr. Marvin Turkanis	Neutron Products
Public Comments Posted to NRC Web Site			
27	1090-0001	Mr. Stephen A. Thompson	U.S. Department of Energy
28	1090-0002	Mr. Jack Hovingh	N/A
29	1090-0003	Ms. Alice Slater	Global Resource Action Center for the Environment
30	1090-0004	Mr. Jay Reese	N/A
31	1090-0005	Mr. John J. Miller	International Isotopes, Inc.
32	1090-0006	Mr. Billy Leaonard	N/A
33	1090-0007	Mr. Thomas Dougherty	Columbiana Hi Tech Front End, LLC
34	1090-0008	Mr. Mark Donham and Ms. Kristi Hanson	Coalition for Nuclear Justice
35	1090-0027	Ms. Jody Lanier	N/A
37	1090-0028	Mr. Robert E. Rutkowski	N/A
38	1090-0029	Mr. B. Geary	N/A

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New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
39	1090-0030	Ms. Roberta Chase and Mr. Mike Schade	Citizens' Environmental Coalition
40	1090-0031	Mr. Richard Geary	N/A
41	1090-0032	Ms. Linda Novenski	N/A
42	1090-0033	Mr. Gerry Welch	St. Louis County Municipal League
43	1090-0035	Mr. B.K. Miles	U.S. Department of Energy
44	1090-0036	Ms. Diane D'Arrigo et al.	Nuclear Information and Resource Service et al.
45	1090-0038	Mr. Peter N. Skinner, P.E.	State of New York, Office of the Attorney General
46	1090-0039	Ms. Sara Barczak	Georgians for Clean Energy
47	1090-0040	Mr. Kent Hancock	Department of Energy
48	1090-0042, 1090-0056	Mr. Donald P. Irwin	Hunton & Williams, on behalf of J.L. Shepard & Associates
50	1090-0043	Mr. Louis Zeller	Blue Ridge Environmental Defense League
51	1090-0044	Ms. Kay Drey	N/A
52	1090-0045	Ms. Barbara Bailine	N/A
53	1090-0046	Ms. Eileen Greene	N/A
54	1090-0047	Mr. Coffie C. Wortham	N/A

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New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
55	1090-0048	Ms. Sheila England	N/A
56	1090-0050	Ms. Pamel Blockey-O'Brian	N/A
58	1090-0051	Ms. Susan R. Gordon	Alliance for Nuclear Accountability
59	1090-0052	Mr. A. Joseph Nardi	Westinghouse Electric Company
60	1090-0054	Mr. Steven A. Toelle	United States Enrichment Corporation
61	1090-0055	Ms. Nisha Dawson	N/A
62	1090-0057	Mr. Patrick R. Simpson	Exelon Generation Company, LLC
64	1090-0058	Mr. Terry C. Morton	Carolina Power & Light and Florida Power Corporation
65	1090-0059	Mr. John Jay Ulloth	N/A
66	1090-0060	Ms. Erin Rogers	N/A
67	1090-0061	Mr. David Bedell	N/A
68	1090-0062	Ms. Elaine Gedige	N/A
69	1090-0063	Ms. Auna T. Rand	N/A
70	1090-0064	Ms. Julia Butera	N/A
71	1090-0065	Mr. Gary A. Karch	N/A
72	1090-0066	Mr. R. Geottler, N. Geoffrey	N/A

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New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
73	1090-0067	Mr. Mark M. Giese	N/A
74	1090-0068	Ms. Valerie Wyman	N/A
75	1090-0069	Ms. Brianna Knoffer	N/A
76	1090-0070, 1090-0071	Ms. Estelle Lit	N/A
77	1090-0072	Ms. Patricia Christian	N/A
79	1090-0073	Mr. Julius Sippen	N/A
80	1090-0074	Mr. Tom Ferguson	Physicians for Social Responsibility
81	1090-0075	Ms. Rebecca Troon	N/A
82	1090-0077	Mr. Thomas Reilly	N/A
83	1090-0078	Ms. Fawn L. Shillinglaw	N/A
84	1090-0079	Ms. Lynne Brock	N/A
85	1090-0081	Ms. Lucille Salitan	N/A
86	1090-0082	Mr. F.L. Holdridge	N/A
87	1090-0083	Mr. Joseph Pastorelli	N/A
88	1090-0084	Mr. J. Weiss	N/A
89	1090-0086	Ms. Joan Carroll	N/A

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New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
90	1090-0087	Mr. Victor Skorapa	N/A
91	1090-0088	Mr. Bruce Grower	N/A
92	1090-0089	Mr. Lloyd Anderson	N/A
93	1090-0090	Mr. C. Stretch	N/A
94	1090-0091	Mr. Thomas LaBarr	N/A
95	1090-0092	Ms. Gladys Mehrmann	N/A
96	1090-0093	Mr. Glenn R. Lee	N/A
97	1090-0094	Mr. Cris Cooley and Ms. Catherine Cooley	N/A
98	1090-0095	Mr. Paul Z. Wright	N/A
99	1090-0096	Ms. Elisabeth Nolan	N/A
100	1090-0097	Ms. Marjory M. Donn	N/A
101	1090-0098	Ms. Margaret Ayers	N/A
102	1090-0100	Ms. Emily B. Calhoun	N/A
103	1090-0101	Mr. Tera Freese	N/A
104	1090-0102	Mr. Chris Ilderton	N/A
105	1090-0103	Ms. Ruth Allen Miner	N/A

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New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
106	1090-0104	Mr. Martin Schulz	N/A
107	1090-0105	Mr. Fredric Sternberg	N/A
108	1090-0106	Mr. Gene Bernardi	N/A
109	1090-0107	Mr. Thomas J. Becker	N/A
110	1090-0108	Ms. Judith B. Evered	N/A
111	1090-0109	Ms. Lorraine Goid	N/A
112	1090-0110	Ms. Diana Holmes	N/A
113	1090-0111	Mr. James Holmes	N/A
114	1090-0112	Mr. Richard Knight	N/A
115	1090-0113	Ms. Kris Listoe	N/A
116	1090-0114	Mr. Joseph Michael	N/A
117	1090-0115	Ms. Frances V. Moulder	N/A
118	1090-0116	Ms. Carolyn Newhouse	N/A
119	1090-0117	Ms. Christine Puente	N/A
120	1090-0118	Mr. Richard Sampson	N/A
121	1090-0119	Ms. Vivian Tatem	N/A
122	1090-0120	Ms. MaryAnn Hannon	N/A

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New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
123	1090-0121	Ms. Maria J. Holt	N/A
124	1090-0122	Mr. M.C. Jackson	N/A
125	1090-0123	Mr. Marley Kellar	N/A
126	1090-0124	Mr. Egan O'Connor	N/A
127	1090-0126	Ms. Maria Maia	N/A
128	1090-0127	Ms. Susan Mills	N/A
129	1090-0128	Ms. Judith H. Johnsrud	Environmental Coalition on Nuclear Power and New England Coalition on Nuclear Power
130	1090-0129		Sierra Club
131	1090-0130	Ms. Jane Dee Hull, Mr. Mike Johanns, Mr. Kenny Guinn, Mr. Gary E. Johnson, Dr. John A. Kitzhaber, Mr. Jim Geringer	States of Arizona, Nebraska, Nevada, New Mexico, Oregon and Wyoming
132	1090-0131	Ms. Joann Myers	N/A
133	1090-0132	Ms. Virginia Wilkins	N/A
134	1090-0133	Mr. Richard Lincoln	N/A
135	1090-0134	Ms. Janice M. Pierson	N/A
136	1090-0135	Ms. Ann Borden	N/A

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137	1090-0136	Mr. Timothy A. Runyon	The Council of State Governments of Midwestern Radioactive Materials Transportation Committee
138	1090-0137	Mr. Robert E. Fronczak	Association of American Railroads
139	1090-0139	Mr. David L. Larkin	Holtec Users Group
140	1090-0140	Ms. Deborah Kelly	N/A
141	1090-0141	Mr. Carl Rupert	N/A
142	1090-0143	Mr. C.M. Vaughan	Global Nuclear Fuel
143	1090-0144	Mr. Carl R. Yates and Mr. David L. Spangler	BWX Technologies
144	1090-0145	Mr. Nabil Al-Hadithy	City of Berkeley
145	1090-0147	Mr. Thomas Baldino	N/A
147	1090-0148	Ms. Genevieve O'Hara and Ms. Dorothy Poor	St. Louis Section of Women's International League for Peace and Freedom
148	1090-0149	Ms. Victoria Fox	N/A
149	1090-0150	Ms. Cheryl Rudin	N/A
150	1090-0151	Ms. Patricia Weikert	N/A
151	1090-0152	Ms. Dori Burg	N/A

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152	1090-0153	Ms. Beverly Dyckman	N/A
153	1090-0154	Ms. Kathleen Sullivan	N/A
154	1090-0155	Ms. Christina Eliason	N/A
155	1090-0156	Mr. Mike Weintraub	N/A
156	1090-0157	Mr. P.H. Snyder	N/A
157	1090-0158	Ms. Maria Pendzich	N/A
158	1090-0159	Ms. Laura Drey	N/A
159	1090-0160	Mr. John LaFarge	Nukewatch
160	1090-0161	Ms. Grace Aaron	N/A
161	1090-0162	Mr. Neil Rudin	N/A
162	1090-0163	Mr. N. Black	N/A
163	1090-0164	Ms. Ellen Steinfeld	N/A
164	1090-0165	Ms. Deanna Donovan	N/A
165	1090-0166	Mr. William Hill	N/A
166	1090-0167	Ms. Candy Redley	N/A
167	1090-0168	Ms. Eileen Markzon	N/A
168	1090-0169	Mr. Harold Powell	N/A

List of Commenters			
New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
169	1090-0170	Mr. Robert Campbell	N/A
170	1090-0171	Mr. Jessie Roberson	U.S. Department of Energy
171	1090-0172	Mr. P. Brochman	N/A
172	1090-0173	Mr. K. DeSchane	N/A
173	1090-0174	Mr. Carl Milch	N/A
174	1090-0175	Ms. Susan Carrol	N/A
175	1090-0176	Ms. Susan Bergman	N/A
176	1090-0177	Ms. Sue Wallace	N/A
177	1090-0178	Ms. Katie Peck	N/A
178	1090-0179	Ms. Angela Graziano	N/A
179	1090-0180	Mr. Weldon Rucker	City of Berkeley, Office of the City Manager
180	1090-0181	Mr. Lee Renna	N/A
181	1090-0182	Ms. Pamela Rubin	N/A
182	1090-0183	Mr. Louise Lumeri	N/A
183	1090-0184	Mr. Kali Jamison and Mr. James Jamison	N/A
184	1090-0185	Ms. Julia Kirchen	N/A

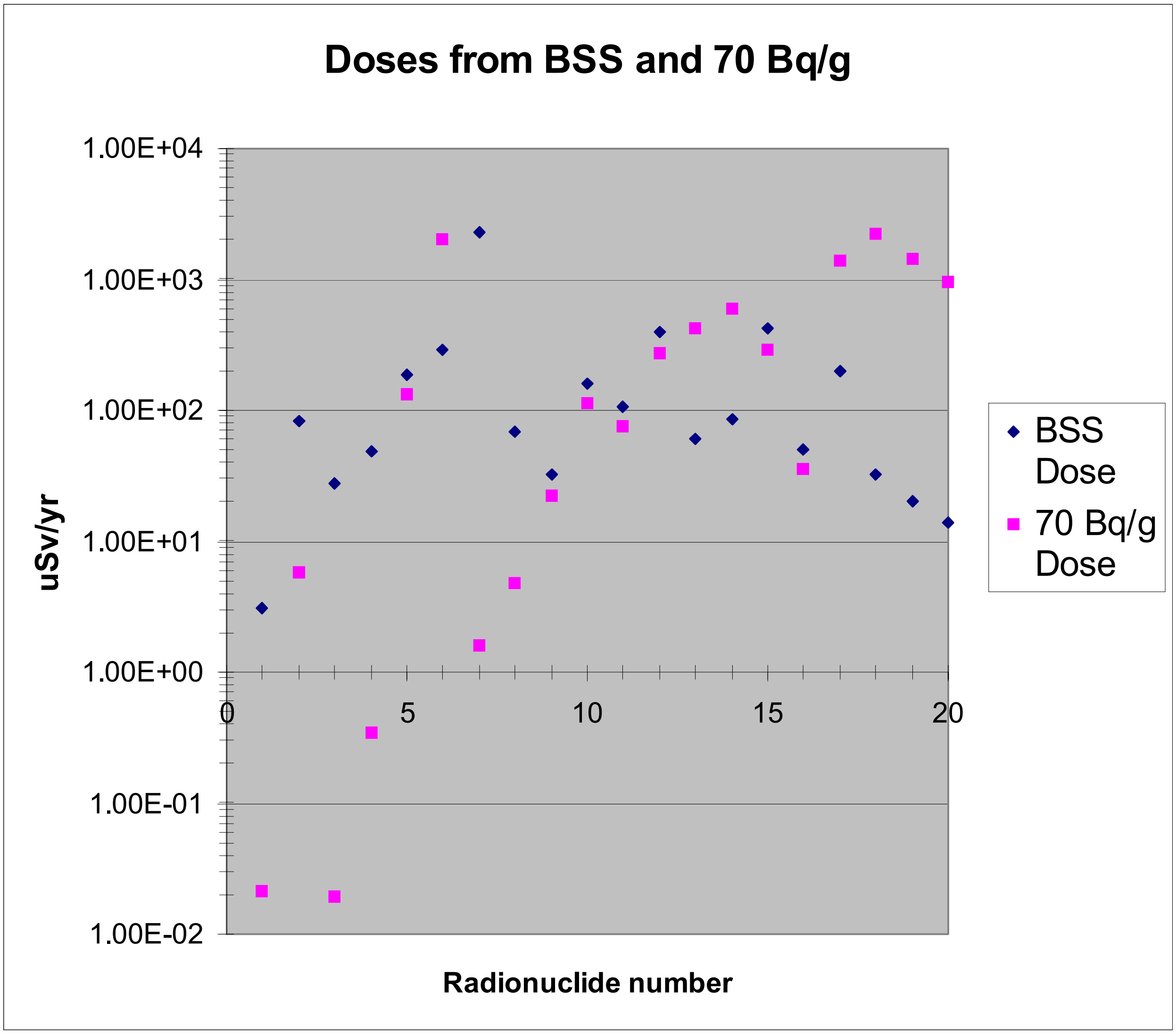
List of Commenters			
New Commenter Number	**Old Commenter Number**	**Commenter Name**	**Affiliation**
185	1090-0186	Ms. Marie Moore	Nuclear Fuel Services, Inc.
186	1090-0187	Ms. Linda Thurston	N/A
187	1090-0188	Mr. Charles Benett	N/A
188	1090-0189	Ms. Julia Abatelli	N/A
189	1090-0190	J. Pearl	N/A
190	1090-0191	Ms. Jennifer Trebenon	N/A
191	1090-0192	Ms. Sara McArdle	N/A
192	1090-0193	Y. T. Zeidlyn	N/A
193	1090-0194	Ms. Patrice M. Bubar	U.S. Department of Energy
194	1090-0195	Mr. Robert C. Anderson	N/A
195	1090-0196	Mr. Schuyler Watts	N/A
197	1090-0197	Mr. M. K. Silva	Environmental Evaluation Group

APPENDIX C

APPENDIX C
Analysis of Changes to Exemption Values

The following is a brief analysis performed by Richard Rawl of Oak Ridge National Laboratory in support of the June 24, 2002 “roundtable” workshop public meeting held in Rockville, MD.

The analysis is designed to highlight how significant the changes to exemption values will be for a number of isotopes, in both visual and tabular format.



Radionuclide	BSS rounded activity conc. (1) [Bq/g]	Transport activity conc.(2) [Bq/g]	BSS Dose [uSv] BSS/transport x10uSv	70 Bq/g Dose [uSv] 70 Bq/g divided by Transport activity conc. (2) x 10 uSv
C-14	1.00E+04	3.26E+04	3.07E+00	2.15E-02
P-32	1.00E+03	1.20E+02	8.33E+01	5.83E+00
S-35	1.00E+05	3.59E+04	2.79E+01	1.95E-02
Cl-36	1.00E+04	2.04E+03	4.90E+01	3.43E-01
K-40	1.00E+02	5.35E+00	1.87E+02	1.31E+02
Co-60	1.00E+01	3.42E-01	2.92E+02	2.05E+03
Kr-85	1.00E+05	4.34E+02	2.30E+03	1.61E+00
Sr-89	1.00E+03	1.46E+02	6.85E+01	4.79E+00
Sr-90+	1.00E+02	3.10E+01	3.23E+01	2.26E+01
Mo-99	1.00E+02	6.25E+00	1.60E+02	1.12E+02
Tc-99m	1.00E+02	9.30E+00	1.08E+02	7.53E+01
I-131	1.00E+02	2.53E+00	3.95E+02	2.77E+02
Cs-137+	1.00E+01	1.65E+00	6.06E+01	4.24E+02
Ir-192	1.00E+01	1.18E+00	8.47E+01	5.93E+02
Au-198	1.00E+02	2.39E+00	4.18E+02	2.93E+02
Tl-201	1.00E+02	1.99E+01	5.03E+01	3.52E+01
Ra-226+	1.00E+01	4.96E-01	2.02E+02	1.41E+03
Th-232N	1.00E+00	3.13E-01	3.19E+01	2.24E+03
U-238N	1.00E+00	4.93E-01	2.03E+01	1.42E+03
Pu-239	1.00E+00	7.30E-01	1.37E+01	9.59E+02

Radionuclide	BSS rounded activity conc. (1) [Bq/g]	Transport activity conc.(2) [Bq/g]	BSS Dose [uSv] BSS/transport x10uSv	70 Bq/g Dose [uSv] 70 Bq/g divided by Transport activity conc. (2) x 10 uSv
Average Dose [uSv/yr]			2.30E+02	5.02E+02
Average Dose [mrem/yr]			2.30E+01	5.02E+01
Std. Dev.			4.91E+02	7.00E+02
Median			7.59E+01	1.21E+02
(1) SS No. 115				
(2) CT/PST6/1540/1123 Table 2, col.4				
	means an increase of dose			
	means no significant change (<E+1)			
(no fill)	means a decrease of dose			