Issue 5. Introduction of the Criticality Safety Index Requirements

Background. Historically, the IAEA and U.S. regulations (both NRC and DOT) have used a term known as the Transport Index (TI) to determine appropriate safety requirements during transport. TI has been used to control the accumulation of packages for both radiological safety and criticality safety purposes and to specify minimum separation distances from persons (radiological safety). The TI has been a single number which is the larger of two values: the "TI for criticality control purposes"; and the "TI for radiation control purposes." Taking the larger of the two values has ensured conservatism in limiting the accumulation of packages in conveyances and in-transit storage areas.

TS-R-1 (paragraph 218) has introduced the concept of a Criticality Safety Index (CSI) separate from the old TI. As a result, the TI was redefined in TS-R-1. The CSI is determined in the same way as the "TI for criticality control purposes," but now it must be displayed on shipments of fissile material (paragraphs 544 and 545) using a new "fissile material" label. The redefined TI is determined in the same way as the "TI for radiation control purposes" and continues to be displayed on the traditional "radioactive material" label.

TS-R-1 (paragraph 530) also increased the per package TI limit [for criticality control purposes (new CSI)] from 10 to 50 for nonexclusive use shipments. No change was made to the per package radiation TI limit of 10 for nonexclusive use shipments. As noted above, a consolidated radiation safety and criticality safety index existed in the past. In this consolidated index, the per package TI limit of 10 was historically based on radiation safety concerns regarding the fogging of photographic film in transit, because film might also be present on a nonexclusive use conveyance. Consequently, when the single radiation and criticality safety indexes were split into the TI and CSI indexes, the IAEA determined that the CSI per package limit, for fissile material packages that are shipped on a nonexclusive use conveyance, could be raised from 10 to 50. The IAEA believed that limiting the total CSI to less than or equal to 50 in a nonexclusive use shipment provided sufficient safety margin, whether the shipment contains a single package or multiple packages. Therefore, the per package CSI limit, for nonexclusive use shipments, can be safely raised from 10 to 50, thereby providing additional flexibility to shippers. Additionally, no change was made to the per package CSI limit of 100 for exclusive use shipments.

Discussion. Comments received on this proposal indicated that the industry supports the use of the new label "CSI" in conjunction with the "TI" labels, and stated that separate labels are more meaningful and provide additional safety in transport, as long as the two labels are distinctive, so as to avoid confusion.

In general, public comments received at the meetings supported the use of the CSI. One commenter believed that using the TI as the means to control criticality safety does not provide emergency responders with information on the undamaged condition of the package. Other commenters suggested that NRC should provide the underlying technical justification for the term "equivalent safety," because otherwise, this change would seemingly allow for more packages in a single shipment. **The use of CSI** provides an equivalent **level of safety to using a TI,** because the CSI uses the same methodology (§ 71.59) that was used to calculate the criticality **portion** of the current TI.

One industry commenter disagreed that the CSI requirement is appropriate. The commenter stated that the TI already incorporates the more restrictive value and provides adequate protection. The commenter believed there is no increase in safety by adding this new requirement and, in fact, it would result in more opportunities for human error. Further, the commenter indicated that any benefit for adding the CSI is far outweighed by the additional labor, material, training, and administration costs that would be borne by a company that ships thousands of packages each year.

Increasing the CSI per package limit from 10 to 50, for nonexclusive use shipments, was overlooked by NRC staff and was not discussed in the June 2000 Issues Paper or the associated public meetings. Consequently, no stakeholder input was obtained on this aspect of Issue 5, prior to developing the proposed rule.

The NRC draft RA indicates that introducing new criticality safety index requirements into Part 71 is appropriate from a safety, regulatory, and cost perspective. NRC would require that applicants for fissile material package design approvals clearly indicate the CSI value for the design. The CoCs the NRC issues for these designs would also need to clearly indicate the CSI value for authorized contents. The adoption of the CSI values would make Part 71 consistent with TS-R-1, therefore enhancing regulatory efficiency.

The NRC staff believes that shipping fissile material packages in accordance with the proposed requirements on either an exclusive use or nonexclusive use conveyance each provides a reasonable assurance that public health and safety and the environment

will be adequately protected. Furthermore, shipment on a nonexclusive use conveyance of a single package with a CSI equal to 50, a shipment of 5 packages each with a CSI equal to 10, or 20 packages each with a CSI equal to 2.5, are all safe and provide reasonable assurance of adequate protection. While NRC staff recognizes that the reactivity per package will increase, with an increase in the CSI from 10 to 50, staff also believes the limit of 50 on total CSI in a nonexclusive use shipment provides adequate protection against mishandling events. Accordingly, this change will not have a significant safety impact.

The total annual estimated cost of the new label to the nuclear power licensees and material licensees is approximately $1.4 million on approximately 2.8 million shipments. Some of these costs would be offset by the fact that for some shipments of fissile material packages, the accumulation of packages for criticality control purposes and the accumulation of packages (including minimum separation distances from persons) for radiological control purposes are shipped independently (the most restrictive criteria would not control the other as is the case with the current dual-use TI). Further, increased efficiency in shipping some fissile material packages could occur by avoiding the situation where separation distance requirements (radiological safety) unduly restrict package accumulation (criticality safety). From a health and safety perspective, emergency responders in accident circumstances (thus public health and safety) benefit from more clearly displayed information upon arrival at the accident scene.

The NRC staff was unable to estimate the magnitude of the impact or cost savings that would arise to licensees due to the increase in the CSI per package limit. However, staff judged that cost savings could be realized, because of increased licensee flexibility in shipping a larger number of fissile material packages on less expensive, nonexclusive use conveyances. Therefore, the NRC is requesting stakeholder input on the quantity of shipments in a typical year that would be affected by an increase in the per package CSI limit from 10 to 50, for nonexclusive use shipments, and any associated cost savings. Because of lack of data, the NRC is also requesting stakeholder input on the current number of fissile material shipments typically made per year (i.e., fissile-exempt, fissile general license, or Type A(F) or B(F) packages); the types of material shipped (e.g., waste, laboratory quantities, or production quantities); the shipment method used for these types of fissile material; and whether these shipments are exclusive or nonexclusive use.

NRC Proposed Position. The NRC proposes to adopt the TS-R-1 (paragraph 218) which incorporates a CSI in Part 71 that would be determined in the same manner as the current Part 71 "TI for criticality control purposes." **The NRC also proposes to adopt TS-R-1 (paragraph 530) which increases the CSI per package limit from 10 to 50, fissile material packages in nonexclusive use shipments.** A TI will be determined in the same way as the "TI for radiation control purposes." The NRC believes the differentiation between criticality control and radiation protection would better define the hazards associated with a given package and, therefore, provide better package hazard information to emergency responders. **The increase in the per package CSI limit may provide additional flexibility to licensees by permitting the increased use of less-expensive, nonexclusive use shipments. However, licensees will still retain the flexibility to ship a larger number of packages of fissile material on an exclusive use conveyance.**

Affected Sections. **§§** 71.4, 71.18, 71.20, 71.59.

Issue 16. Fissile Material Exemptions and General License Provisions

Background. The NRC published an emergency final rule amending **its regulations** on shipments of small quantities of fissile material (62 FR 5907; February 10, 1997). This rule revised the regulations on fissile exemptions in § 71.53 and the fissile general licenses in §§ 71.18 and 71.22. The NRC determined that good cause existed, **under Section** 553(b)(B) of the Administrative Procedure Act (APA) (5 U.S.C. 553(b)(B)), to publish this final rule without notice and opportunity for public comment. Further, the NRC also determined that good cause existed, under Section 553(d)(3) of the APA (5 U.S.C. 553(d)(3)), to make this final rule immediately effective. Notwithstanding the final status of the rule, the NRC provided for a 30-day public comment period. The NRC subsequently published in the Federal Register (64 FR 57769; October 27, 1999) a response to the comments received on the emergency final rule and a request for information on any unintended economic impacts caused by the emergency final rule.

The NRC issued this emergency final rule in response to a regulatory defect in the fissile exemption regulation in § 71.53 which was identified by an NRC licensee. The licensee was evaluating a proposed shipment of a special fissile material and moderator mixture (beryllium oxide mixed with a low concentration of high-enriched uranium). The licensee concluded that

while § 71.53 was applicable to the proposed shipment, applying the requirements of § 71.53 could, in certain circumstances, result in an inadequate level of criticality safety (i.e., an accidental nuclear criticality was possible in certain unique circumstances).[1]

The NRC staff confirmed the licensee's analysis that this beryllium oxide and high-enriched uranium mixture created the potential for inadequate criticality safety during transportation. An added factor in the urgency of the situation was that under the NRC regulations in §§ 71.18, 71.20, 71.22, 71.24, and 71.53, these types of fissile material shipments could be made without prior approval of the NRC. For many years, the NRC allowed these shipments of small quantities of fissile material based on the NRC's understanding of the level of risk involved with these shipments, as well as industry's historic transportation practices. This experience base had led the NRC (and its predecessor, the Atomic Energy Commission (AEC)) to conclude that shipments made under the fissile exemption provisions of Part 71 typically required minimal regulatory oversight (i.e., the NRC considered these types of shipments to be inherently safe).[2]

All public comments on the emergency final rule supported the need for limits on special moderators (i.e., moderators with low neutron-absorption properties such as beryllium, graphite, and deuterium). However, the commenters stated that the restrictions were far too limiting (to the point that some inherently safe packages were excluded from the fissile exemption) and could lead to undue cost burdens with no benefit to safety. In addition, the commenters believe that the consignment mass limits set to deter undue accumulation of fissile mass would be extremely costly. Therefore, the commenters recommended that further rulemaking was

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[1] For transportation purposes, “nuclear criticality” means a condition in which an uncontrolled, self-sustaining, and neutron-multiplying fission chain reaction occurs. “Nuclear criticality” is generally a concern when sufficient concentrations and masses of fissile material and neutron moderating material exist together in a favorable configuration. Neutron moderating material cannot achieve criticality by itself in any concentration or configuration. However, it can enhance the ability of fissile material to achieve criticality by slowing down neutrons or reflecting neutrons.

[2] The NRC's regulations in Part 71 ensure protection of public health and safety by requiring that Type AF, B, or BF packages used for transportation of large quantities of radioactive materials be approved by the NRC. This approval is based upon the NRC's review of applications which contain an evaluation of the package's response to a specific set of rigorous tests to simulate both normal conditions of transport (NCT) and hypothetical accident conditions (HAC). However, certain types of packages are exempted from the testing and NRC prior approval; these are fissile material packages that either contain exempt quantities (§ 71.53), or are shipped under the general license provisions of §§ 71.18, 71.20, 71.22, or 71.24.

necessary to resolve these excessive restrictions. Based on the public comments on the emergency final rule, NRC staff contracted with Oak Ridge National Laboratory (ORNL) to review the fissile material exemptions and general license provisions, study the regulatory and technical bases associated with these regulations, and perform criticality model calculations for different mixtures of fissile materials and moderators. The results of the ORNL study were documented in NUREG/CR-5342,[3] and the NRC published a notice of the availability of this document in the Federal Register (63 FR 44477; August 19, 1998). The ORNL study confirmed that the emergency final rule was needed to provide safe transportation of packages with special moderators that are shipped under the general license and fissile material exemptions, but the regulations may be excessive for shipments where water moderation is the only concern. The ORNL study recommended that the NRC revise Part 71.

Subsequently, the NRC published a Federal Register notice that responded to public comments on the emergency final rule and requested additional information on the cost impact of the emergency final rule from the public, industry, and the DOE (64 FR 57769; October 27, 1999). The Commission requested this cost impact information because the NRC staff was not successful in obtaining this information. Specifically, the NRC requested information on the cost of shipments made under the fissile material exemptions and general license provisions of Part 71 before the publication of the emergency final rule, and those costs and/or changes in costs resulting from implementation of the emergency rule. One commenter agreed with the NRC approach, but stated that, "the limits for those materials containing no special moderators can and should be increased, hopefully back to their pre-emergency rule levels."

As part of NUREG/CR-5342, ORNL performed computer model calculations of k_{eff} (k-effective) for various combinations of fissile material and moderating material, including beryllium, carbon, deuterium, silicon-dioxide, and water, to verify the accuracy of current minimum critical mass values. These minimum critical mass values were then applied to the regulatory structure contained in Part 71, and revised mass limits for both the general license and exemption provisions to Part 71 were determined. Also, ORNL researched the historical bases for the fissile material exemption and general license regulations in Part 71 and discussed the impact of the emergency final rule's restrictions on NRC licensees. ORNL concluded that the restrictions imposed by the emergency final rule were necessary to address

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

concerns relative to uncontrolled accumulation of exempt packages (and thus fissile mass) in a shipment and the potential for inadequate safety margin for exempt packages with large quantities of special moderators.

Based on its new k_{eff} calculations, ORNL suggested that: (1) the mass limits in the general license and exemption provisions could be safely increased and thereby provide greater flexibility to licensees shipping fissile radioactive material; and (2) additional revisions to Part 71 were appropriate to provide increased clarification and simplification of the regulations. NUREG/CR-5342 is available electronically in the Reference Library area of the NRC's Home Page under Technical Reports (http://www.nrc.gov) or the NRC's Public Electronic Reading Room. Also, copies of NUREG/CR-5342 may be obtained by writing to the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402-9328. Copies are also available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161-0002. A copy is also available for inspection and copying, for a fee, at the NRC Public Document Room in the NRC Headquarters at One White Flint North, Room O-1F21, 11555 Rockville Pike, Rockville, MD 20852-2738.

Discussion. The NRC has received public comments on this issue in response to the issues paper, public meetings, and the workshop. Industry representatives, public interest organizations, Agreement States, and members of the public supported the issue. None of the comments presented new issues from those previously presented in response to the emergency final rule or the Commission's request for additional cost information.

Addressing the emergency final rule, one commenter agreed with the necessity for the rule, but stated that there are issues yet to be resolved for water moderated shipments. In comparison, another commenter took issue with our stated goal and NRC's methods. This commenter believed that if NRC adopts these provisions, then NRC will be unable to conform with TS-R-1. The commenter cited as evidence a statement in the issues paper, "IAEA standard ST-1 (nee TS-R-1) contains language on fissile exemptions and restrictions on the use of special moderators. However, ST-1 does not currently contain provisions on general licenses for shipment of fissile material."

Similarly, one commenter raised the importance of coordinating regulatory actions on fissile material exemptions with the international community. The commenter noted the international community's interest in fissile material exemptions and encouraged NRC to listen to its international counterparts at the next IAEA meeting; the commenter's goal being to ensure

that NRC is not out of step with the rest of the world (i.e., fissile material exempt in the U.S. is not exempt elsewhere, and vice-versa).

One commenter raised questions concerning specific recommendations in NUREG/CR-5342. The commenter was concerned in how recommendations 3 and 4 would introduce unnecessary complexity and noted that this concern vanishes if the TS-R-1 definitions for regulated material are adopted. The commenter also stated that recommendation 17 could seemingly eliminate the fissile excepted category, which is something the commenter did not want to see occur. If such a change is necessary, the commenter requested that the NRC instead revise the excepted package's definition to reduce the amount of fissile material present and ensure that 10 CFR 71.53 and 49 CFR 173.453 are consistent with TS-R-1 (i.e., with respect to upper limits on a package's fissile material, as well as the total amount of fissile material in a fissile exempt consignment).

The current restrictions on fissile exempt and general license shipments under §§ 71.53, and 71.18 through 71.24, respectively, are burdensome for a large number of shipments that actually contain no special moderating materials (i.e., packages that are shipped with water considered as the potential moderating material). This problem was clearly expressed in public comments on the emergency final rule. Another regulatory problem is that the current fissile exempt and general license provisions are cumbersome and outdated; this was one of the main conclusions of the ORNL study. Therefore, the NRC would update, simplify, and streamline these sections of Part 71 to eliminate regulatory confusion.

The proposed revisions in Table 16-1 are based on public comments received on the February 10, 1997, emergency final rule, on the subsequent Commission's direction in SRM-SECY-99-200 regarding the unintended economic impact of that emergency final rule, and on the latest public comments received on the July 2000 issues paper. Altogether, ORNL suggested 17 changes to the Part 71 regulations in NUREG/CR-5342. A summary of these changes and the NRC's assessment and recommendation are contained in Table 16-1. NUREG/CR-5342 contains a more detailed discussion of the proposed changes listed in Table 16-1 and ORNL's supporting calculations.

Table 16-1
Summary of Recommended Changes in NUREG/CR-5342

Description of Issue	NRC Staff Recommendation
Issue 16-1: Definitions for "consignment," "consignor," and "shipper" should be provided to reduce confusion between regulations in 49 CFR Part 173 and 10 CFR Part 71.	Disagree. These changes are not necessary with the use of mass ratio limits and a criticality safety index when combined with the current requirement in § 71.59.
Issue 16-2: Plutonium-238 should be removed from the definition of "fissile material," because ^{238}Pu is only fissionable, not fissile.	Agree.
Issue 16-3: The exemption for radioactive material in § 71.10(a) should be revised to exclude fissile material. ORNL's concern was that a large quantity of a low-concentration fissile material could pose a criticality safety concern. The revised k_{eff} calculations indicate that a 43 Bq/g (1.16 x 10^{-3} µCi/g) limit for fissile material (^{235}U) would be necessary. However, other fissile nuclides have higher limits (e.g, 6,230 Bq/g (0.168 µCi/g) for ^{233}U or 66,000 Bq/g (1.784 µCi/g) for ^{241}Pu) or the Appendix A, new Table A-2, values are only 10 Bq/g (2.7 x 10^{-4} µCi/g) (e.g., ^{239}Pu).	Disagree. The existing exception to the exemption in paragraph (b) would be maintained (i.e., the reference to the fissile exemption in new § 71.15). However, no change would be made to paragraph (a) because the values in Table A-2 are less than 43 Bq/g (1.16 x 10^{-3} µCi/g) or the fissile nuclides have criticality limits which would be higher than the exempt concentration limits of Table A-2.
Issue 16-4: The exemption for radioactive material in existing § 71.10 should be revised to require shipment in an acceptable package as required by existing § 71.11 to improve safety.	Agree.
Issue 16-5: Section 71.53 should be relocated from Subpart E — Package Approval Standards, to Subpart B — Exemptions, to provide greater consistency in Part 71. (Note: § 71.53 would also be redesignated as § 71.15.)	Agree.
Issue 16-6: The NRC or DOT should keep a database of shipments made under the fissile exemption or general licenses. Section 71.97 should be revised to require licensees to keep these records and report this information.	Disagree. The licensee's burden in keeping and reporting these records is not commensurate with the safety risk for fissile exemption shipments.

Issue 16-7: The provisions for plutonium-beryllium (Pu-Be) shipments should be removed from the four general licenses of existing §§ 71.18, 71.20, 71.22, and 71.24 and consolidated in a new general license. The mass limits for Pu-Be shipments should be reduced, because the revised k_{eff} calculations indicate potential safety problems exist with the current limits.	Agree.
Issue 16-8: The general licenses of existing §§ 71.18, 71.20, 71.22, and 71.24 should be consolidated into one general license to simplify the regulations and consistently apply the criticality safety index (CSI).	Agree.
Issue 16-9: The distinction between quantities of ^{235}U that can be shipped in a uniform distribution and nonuniform distribution should be eliminated from the general licenses. The bounding nonuniform quantities should be used to simplify compliance with the rule.	Agree.
Issue 16-10: Restrictions on the quantities of Be, C, and D_2O to less than 0.1% should be removed for the general licenses. A maximum of 500g of Be, C, and D_2O per package should be imposed to preclude the potential for these materials to be effective as reflector materials.	Agree.
Issue 16-11: A separate mass control or restriction for moderators having a hydrogen density greater than water should be retained for general licenses. For mixtures of moderators, lower mass limits should be imposed if more than 15% of the moderating material has a moderating effectiveness greater than the hydrogen density of water. Use of a 15% mixture limit would reduce confusion when mixtures of moderators are present in a shipment.	Agree.
Issue 16-12: Package mass limits for general licenses may be increased to reflect results of new analyses and still maintain equivalence of safety as provided for certified packages.	Agree. Also, minimum package requirements should be established. However, imposing § 71.43 requirements would be excessive for the commensurate risk from these shipments. Instead, the DOT Type A package requirements should be used.
Issue 16-13: Package mass limits for general licenses should be revised to reflect the new k_{eff} calculations. These mass limits can be safely increased.	Agree.

Issue 16-14: The mass-limit based exemption in existing § 71.53(a) should be changed to a mass-ratio based approach. In contrast to concentration-based approaches with consignment limits that are now in use in the fissile exemptions, the mass-ratio approach should provide a simpler, more cost-effective approach to preventing the formation of system configurations having inadequate subcritical margins as a result of transport scenarios (§§ 71.71 and 71.73).	Agree.
Issue 16-15: If a mass-ratio approach is used, the restrictions on Be, C, and D_2O in existing § 71.53(a), (c), and (d) should be removed.	Agree.
Issue 16-16: The exemption for uranyl nitrate solutions in § 71.53(c) should include a packaging requirement from existing § 71.43.	Agree, in part. Minimum package requirements should be established. However, § 71.43 is excessive for the commensurate risk from these shipments. The DOT Type A package requirements should be used.
Issue 16-17: The exemption for uranium enriched to less than 1 wt % ^{235}U in existing § 71.53(b) should be modified to remove the homogeneity requirements and lattice prevention requirement. Instead, retain the 0.1% Be, C, and D_2O limit because of the difficulty in defining and applying "homogenous" and "lattice arrangement" restrictions.	Agree.

In addition to the recommendations contained in NUREG/CR-5342, the Commission directed the NRC staff, in SRM-M970122B on SECY-96-268, to issue additional guidance in instances where fissile materials may be mixed in the same shipping container with different moderators (i.e., materials of differing moderator effectiveness). Therefore, the NRC would add a note to Table 71-1 in existing § 71.22 to use reduced mass limits if more than 15 percent of the moderating materials in a package have a moderating effectiveness greater than the average hydrogen density of H_2O (see Issue 16-11 in Table 16-1 above).

The NRC believes these changes would provide greater flexibility in the shipment of fissile material under the fissile exemption and general license regulations. The NRC would revise these requirements using a risk-informed approach, and address the burden and excessiveness issues raised in the public comments on the emergency final rule. The NRC would use a graduated regulatory approach in establishing requirements for the shipment of fissile material. The graduated approach would involve three tiers of regulations consisting of:

(1) the fissile material exemptions with low fissile mass limits and minimal requirements (i.e., the new § 71.15); (2) the fissile general licenses with higher mass limits and packaging and QA requirements (i.e., the new §§ 71.22 and 71.23); and (3) the Type AF, BF, B(U)F, or B(M)F fissile material packages with large mass limits that require prior NRC approval of the package design (i.e., the existing § 71.55). The NRC believes this approach would establish a risk-informed framework by imposing progressively stricter requirements as the quantity of fissile material being shipped increases (i.e., the criticality hazard increases). In accomplishing this risk-informed approach, some mass limits in the general licenses would increase, and others would decrease. These changes would reflect the new k_{eff} calculations in NUREG/CR-5342. To counterbalance the increases in mass limits in the general licenses, requirements would be added on the use of a Type A package, a CSI, and an NRC-approved QA program.

While the NRC is proposing to adopt the use of the CSI for general licensed fissile packages, the NRC is proposing retaining the current per package (CSI) limit of 10, rather than raising the per package limit to 50 (see Issue 5). TS-R-1 does not address the issue of fissile general licenses, so no compatibility issues arise with retention of the current NRC per package limit of 10. NRC staff believes that because reduced regulatory oversight is imposed on fissile general license shipments (e.g., the package standards of §§ 71.71 and 71.73, fissile package standards of § 71.55, and fissile array standards of § 71.59 are not imposed for fissile general license shipments), retention of the current per package limit of 10 is appropriate. Furthermore, retention of the current per package limit of 10 would not impose a new burden on licensees; rather, licensees shipping fissile material under the general license provisions of §§ 71.22 and 71.23 would not be permitted to take advantage of the relaxation of the per package CSI limit from 10 to 50 that would be permitted for Types A(F) and B(F) package shipments.

Overall, the NRC would amend Part 71 as follows: (1) revise § 71.10, "Exemption for low level material," to exclude fissile material, also redesignate § 71.10 as 71.14 ; (2) redesignate § 71.53 as §71.15, "Exemption from classification as fissile material," and revise the fissile exemptions; (3) consolidate the existing four general licenses in **existing** §§ 71.18, 71.20, 71.22, and 71.24 into one general license in new § 71.22, revise the mass limits, and add Type A package, CSI, and QA requirements; and (4) consolidate the existing general licenses requirements for plutonium-beryllium sealed sources, which are contained in existing §§ 71.18 and 71.22 into one general license in new § ~~71.20~~ **71.23** and revise the mass limits.

Additionally, conforming changes would be made to **§ 71.4, "Definitions"**~~; to § 71.59, "Standards for arrays of fissile material packages";~~ **and § 71.100, "Criminal penalties."**

The NRC draft RA indicates that incorporating revisions to the fissile material exemption and general license provisions in Part 71 is appropriate from a safety, regulatory, and cost perspective. As stated earlier, there is a shortage of data on the fissile material general license and exempt shipments; consequently, the NRC was not successful in obtaining data to quantify the economic impact which would result from adopting some or all of the 17 recommendations in NUREG/CR-5342. The impact of these amendments on the licensees and the NRC would be both positive and negative, depending on the specific recommendation. Recommendations 1, 2, and 5 would enhance regulatory efficiency due to the increase in clarity of the NRC regulations. Recommendations 3, 4, 6, 9, and 12 would increase costs to licensees. Recommendations 7, 8, 10, 13, 14, and 15 would eliminate the potential for criticality accidents, which would, in turn, yield environmental and public health and safety benefits. Finally, recommendations 11, 16, and 17 would result in savings to licensees.

NRC Proposed Position. The NRC proposes revisions to the fissile material exemptions and the general license provisions in Part 71.

Affected Sections. **§§** 71.4, 71.10, 71.11, 71.18, 71.20, 71.22, 71.24, 71.53, 71.59, and 71.100.

§71.4 Definitions.

The following terms are as defined here for the purpose of this part. To ensure compatibility with international transportation standards, all limits in this part are given in terms of dual units: The International System of Units (SI) followed or preceded by U.S. standard or customary units. The U.S. customary units are not exact equivalents, but are rounded to a convenient value, providing a functionally equivalent unit. For the purpose of this part, either unit may be used.

A_1 means the maximum activity of special form radioactive material permitted in a Type A package. This value is either listed in Appendix A, Table A-1, of this part, or may be derived in accordance with the procedures prescribed in Appendix A of this part.

A_2 means the maximum activity of radioactive material, other than special form material, LSA, and SCO material, permitted in a Type A package. This value is either listed in Appendix A, Table A-1, of this part, or may be derived in accordance with the procedures prescribed in Appendix A of this part.

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

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

Certificate of compliance (CoC) means the certificate issued by the Commission under either subpart D or I of this part which approves the design of a package for the transportation of radioactive material.

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

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

Conveyance means:

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

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

(3) For transport by aircraft any aircraft.

Criticality safety index (CSI) means the dimensionless number (rounded up to the next tenth) assigned to and placed on the label of a fissile material package, to designate the degree

of control of accumulation of packages containing fissile material during transportation. Determination of the criticality safety index is described in §§ 71.22, 71.23, and 71.59.

Deuterium means, for the purposes of §§ 71.15 and 71.22, the definition of *Deuterium* as found in § 110.2 of this chapter.

DOT means the U.S. Department of Transportation.

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

Fissile material means the radionuclides uranium-233, uranium-235, plutonium-239, and plutonium-241, or any combination of these radionuclides. Fissile material means the fissile nuclides themselves, not material containing fissile nuclides. 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 § 71.15.

Graphite means, for the purposes of §§ 71.15 and 71.22, the definition of *Nuclear grade graphite* as found in § 110.2 of this chapter.

Licensed material means by-product, source, or special nuclear material received, possessed, used, or transferred under a general or specific license issued by the Commission pursuant to the regulations in this chapter.

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

(1) *LSA - I*.

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

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

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

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

(2) *LSA - II.*

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

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

(3) *LSA - III*. Solids (e.g., consolidated wastes, activated materials) that satisfy the requirements of § 71.77, in which:

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

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

(iii) The average specific activity of the solid does not exceed 2 x10^{-3} A_2/g.

Low toxicity alpha emitters means natural uranium, depleted uranium, natural thorium; uranium-235, uranium-238, thorium-232, thorium-228 or thorium-230 when contained in ores or physical or chemical concentrates or tailings; or alpha emitters with a half-life of less than 10 days.

Maximum normal operating pressure means the maximum gauge pressure that would develop in the containment system in a period of 1 year under the heat condition specified in § 71.71(c)(1), in the absence of venting, external cooling by an ancillary system, or operational controls during transport.

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

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

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

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

(1) *Fissile material package* or Type *AF package, Type BF package, Type B(U)F package,* or *Type B(M)F package* means a fissile material packaging together with its fissile material contents.

(2) *Type A package* means a Type A packaging together with its radioactive contents. A Type A package is defined and must comply with the DOT regulations in 49 CFR Part 173.

(3) *Type B package* means a Type B packaging together with its radioactive contents. On approval, a Type B package design is designated by NRC as B(U) unless the package has a maximum normal operating pressure of more than 700 kPa (100 lbs/in^2) gauge or a pressure relief device that would allow the release of radioactive material to the environment under the tests specified in § 71.73 (hypothetical accident conditions), in which case it will receive a designation B(M). B(U) refers to the need for unilateral approval of international shipments; B(M) refers to the need for multilateral approval of international shipments. There is no distinction made in how packages with these designations may be used in domestic transportation. To determine their distinction for international transportation, see DOT regulations in 49 CFR Part 173. A Type B package approved before September 6, 1983, was designated only as Type B. Limitations on its use are specified in § 71.19.

(4) *Type B(DP) package* means a Type B(DP) packaging together with its radioactive contents. A Type B(DP) package is a dual-purpose package intended for both the transportation and storage of spent fuel. A Type B(DP) package is also a fissile material package. A Type B(DP) package is issued both a certificate of compliance approving the design of a spent-fuel transportation package, in accordance with subpart I of this part, and a certificate of compliance approving the design of a spent fuel storage cask, in accordance with subpart L of part 72 of this chapter.

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

Special form radioactive material means radioactive material that satisfies the following conditions:

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

(2) The piece or capsule has at least one dimension not less than 5 mm (0.2 in); and

(3) It satisfies the requirements of § 71.75. A special form encapsulation designed in accordance with the requirements of § 71.4 in effect on June 30, 1983 (see 10 CFR part 71, revised as of January 1, 1983), and constructed before July 1, 1985, and a special form encapsulation designed in accordance with the requirements of § 71.4 in effect on March 31, 1996 (see 10 CFR part 71, revised as of January 1, 1983), and constructed before April 1, 1998, may continue to be used. Any other special form encapsulation must meet the specifications of this definition.

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

Spent nuclear fuel or *Spent fuel* means fuel that has been withdrawn from a nuclear reactor following irradiation, has undergone at least one year's decay since being used as a source of energy in a power reactor, and has not been chemically separated into its constituent elements by reprocessing. Spent fuel includes the special nuclear material, byproduct material, source material, and other radioactive materials associated with fuel assemblies.

State means a State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands.

Structures, systems, and components important to safety (SSCs) means those features of a Type B(DP) package whose functions are—

(1) To maintain the conditions required to safely transport the package's contents;

(2) To prevent damage to the package during transport; or

(3) To provide reasonable assurance that the radioactive material contents can be received, handled, transported, and retrieved without undue risk to public health and safety and the environment.

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

(1) SCO - I: A solid object on which:

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

(ii) The fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $4x10^4$ Bq/cm^2 (1.0 microcurie/cm^2) for beta and gamma and low toxicity alpha emitters, or $4x10^3$ Bq/cm^2 (0.1 microcurie/cm^2) for all other alpha emitters; and

(iii) The nonfixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $4x10^4$ Bq/cm^2 (1 microcurie/cm^2) for beta and gamma and low toxicity alpha emitters, or $4x10^3$ Bq/cm^2 (0.1 microcurie/cm^2) for all other alpha emitters.

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

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

(ii) The fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $8x10^5$ Bq/cm^2 (20 microcuries/cm^2) for beta and gamma and low toxicity alpha emitters, or $8x10^4$ Bq/cm^2 (2 microcuries/cm^2) for all other alpha emitters; and

(iii) The nonfixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $8x10^5$ Bq/cm^2 (20 microcuries/cm^2) for beta and gamma and low toxicity alpha emitters, or $8x10^4$ Bq/cm^2 (2 microcuries/cm^2) for all other alpha emitters.

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

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

Type A quantity means a quantity of radioactive material, the aggregate radioactivity of which does not exceed A_1 for special form radioactive material, or A_2, for normal form radioactive material, where A_1 and A_2 are given in Table A - 1 of this part, or may be determined by procedures described in Appendix A of this part.

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

Uranium -- natural, depleted, enriched

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

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

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

§ 71.10 Public inspection of application.

Applications for approval of a package design under this part, which are submitted to the Commission, may be made available for public inspection, in accordance with provisions of parts 2 and 9 of this chapter. This includes an application to amend or revise an existing package design, any associated documents and drawings submitted with the application, and any responses to NRC requests for additional information.

§ 71.11 [Reserved]

§ 71.18 General license: NRC-approved Type B(DP) package.

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

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

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

(1) Has a copy of the CoC, or other approval, of the Type B(DP) package, a copy of the updated final safety analysis report for the package, and the drawings and other documents referenced in the CoC, or other approval, relating to the use and maintenance of the packaging and to the actions to be taken before shipment;

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

(3) Submits in writing to the NRC, before the licensee's first use of the package, the licensee's name and license number and the package identification number specified in the package approval. A licensee shall submit this information in accordance with § 71.1.

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

(e) This general license does not authorize a Type B(DP) packages to be transported by air.

§ 71.20 General license: DOT specification container.

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

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

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

(1) Has a copy of the specification; and

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

(d) This general license is subject to the limitation that the specification container may not be used for a shipment to a location outside the United States, except by multilateral approval, as defined in DOT regulations at 49 CFR 173.403.

§ 71.22 General license: Fissile material.

(a) A general license is issued to any licensee of the Commission to transport fissile material, or to deliver fissile material to a carrier for transport, if the material is shipped in accordance with this section. The fissile material need not be contained in a package which meets the standards of subparts E and F of this part; however, the material must be contained in a Type A package. The Type A package must also meet the DOT requirements of 49 CFR 173.417(a).

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

(c) The general license applies only when a package's contents:

(1) Contain less than a Type A quantity of fissile material; and

(2) Contain less than 500 total grams of beryllium, graphite, or hydrogenous material enriched in deuterium.

(d) The general license applies only to **packages containing fissile material that are labeled** with a CSI which:

(1) **H**as been determined in accordance with paragraph (e) of this section;

(2) **H**as a value less than or equal to 10.0; and

(3) **F**or a shipment of multiple **packages containing fissile material, the sum of the CSIs must be less than or equal to 50.5 (for shipment on a nonexclusive use conveyance or storage incident to transport) and ~~to~~ less than or equal to 100.0 (for shipment on an exclusive use conveyance).**

(e)(1) The value for the CSI must be greater than or equal to the number calculated by the following equation:

$$\text{CSI} = 10\left[\frac{\text{grams of } ^{235}\text{U}}{X} + \frac{\text{grams of } ^{233}\text{U}}{Y} + \frac{\text{grams of Pu}}{Z}\right];$$

(2) The calculated CSI must be rounded up to the first decimal place;

(3) The values of *X*, *Y*, and *Z* used in the CSI equation must be taken from Tables 71-1 or 71-2, as appropriate;

(4) If Table 71-2 is used to obtain the value of *X*, then the values for the terms in the equation for uranium-233 and plutonium must be assumed to be zero; and

(5) Table 71-1 values for *X*, *Y*, and *Z* must be used to determine the CSI if:

(i) **U**ranium-233 is present in the package;

(ii) **T**he mass of plutonium exceeds 1 percent of the mass of uranium-235;

(iii) **T**he uranium-235 is of unknown enrichment; or

(iv) **S**ubstances having a moderating effectiveness (i.e., an average hydrogen density greater than H_2O) [e.g., certain hydrocarbon oils or plastics] are present in any form, except as polyethylene used for packing or wrapping.

TABLE 71-1. MASS LIMITS FOR GENERAL LICENSE PACKAGES CONTAINING MIXED QUANTITIES OF FISSILE MATERIAL OR URANIUM-235 OF UNKNOWN ENRICHMENT PER § 71.22(e)

Fissile material	Fissile material mass mixed with moderating substances having an average hydrogen density less than or equal to H_2O. (grams)	Fissile material mass mixed with moderating substances having an average hydrogen density greater than H_2O.[a] (grams)
^{235}U (*X*).....	60	38
^{233}U (*Y*).....	43	27
^{239}Pu or ^{241}Pu (Z).....	37	24

[a] When mixtures of moderating substances are present, the lower mass limits shall be used if more than 15 percent of the moderating substance has an average hydrogen density greater than H_2O.

TABLE 71-2 — MASS LIMITS FOR GENERAL LICENSE PACKAGES CONTAINING URANIUM-235 OF KNOWN ENRICHMENT PER § 71.22(e)

Uranium enrichment in weight percent of ^{235}U not exceeding	Fissile material mass of ^{235}U (X). (grams)
24	60
20	63
15	67
11	72
10	76
9.5	78
9	81
8.5	82
8	85
7.5	88
7	90
6.5	93
6	97
5.5	102
5	108
4.5	114
4	120
3.5	132
3	150
2.5	180
2	246
1.5	408
1.35	480
1	1,020
0.92	1.800

§ 71.24 [Reserved]

§ 71.53 [Reserved]

5. Section 71.53 is removed and reserved.

§ 71.59 Standards for arrays of fissile material packages.

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(b) The CSI must be determined by dividing the number 50 by the value of "N" derived using the procedures specified in paragraph (a) of this section. The value of the CSI may be zero provided that an unlimited number of packages are subcritical, such that the value of "N" is effectively equal to infinity under the procedures specified in paragraph (a) of this section. Any CSI greater than zero must be rounded up to the first decimal place.

(c) **For** a fissile material package **which** is assigned a CSI value —

(1) Less than or equal to 50.0, that package may be shipped **by a carrier in a nonexclusive use conveyance, or stored incident to transport, provided the sum of the CSIs is limited to less than or equal to 50.0.**

(2) Less than or equal to 50.0, that package may be shipped by a carrier in an exclusive use conveyance, provided the sum of the CSIs is limited to less than or equal to 100.0.

(3) Greater than **50.0, that package must be shipped by a carrier in an exclusive use conveyance, provided the sum of the CSIs is limited to less than or equal to 100.0.**

§ 71.100 Criminal penalties.

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(b) The regulations in part 71 that are not issued under **sections** 161b, 161i, or 161o for the purposes of **section** 223 are as follows: §§ 71.0, 71.2, 71.4, 71.6, 71.7, 71.10, 71.31, 71.33, 71.35, 71.37, 71.38, 71.39, 71.40, 71.41, 71.43, 71.45, 71.47, 71.51, 71.55, 71.59, 71.65, 71.71, 71.73, 71.74, 71.75, 71.77, 71.99, 71.100, and 71.151 through 71.169.