



UNITED STATES
NUCLEAR REGULATORY COMMISSION
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December 1, 2000

MEMORANDUM TO: Susan F. Shankman, Deputy Director
Licensing and Inspection Directorate
Spent Fuel Project Office, NMSS

THROUGH: Michael Tokar, Chief 
Transportation and Storage Safety
and Inspection Section
Spent Fuel Project Office, NMSS

FROM: Robert Lewis 
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SUBJECT: TRIP REPORT, IAEA CONSULTANT SERVICES MEETING,
OCTOBER 30, 2000 TO NOVEMBER 4, 2000

From October 30, 2000, to November 4, 2000, Mr. R. Lewis of the Spent Fuel Project Office served as the chairman of Consultant Services Meeting No. 120 (CSM-120) at the International Atomic Energy Agency (IAEA) Headquarters in Vienna, Austria. Mr. Lewis' travel was funded by the IAEA. CSM-120 was basically a writing group, assembled to identify issues and produce an initial draft IAEA guidance document entitled, "Transitional Arrangements between the 1985 (as amended 1990) and 1996 Editions of the Transport Regulations." IAEA's plan for the guidance is that it would eventually be published as an IAEA TECDOC-series report. The two other members of the CSM included Mr. Ian Barlow representing the U.K. Department of the Environment, Transport and the Regions; and Mr. Bernd Lorentz, of GNS in Germany but representing the World Nuclear Transport Institute.

The IAEA transportation regulations, "Regulations for the Safe Transport of Radioactive Material" (formerly known as ST-1 but the English version was recently redesignated as TS-R-1), were revised in 1996 with a baseline world-wide adoption date of January 1, 2001, by Member State regulatory bodies and international modal organizations. However, in practice the adoption of these regulations will be delayed by most modal organizations and in most countries (including the U.S.), leading to a situation in which different regulatory requirements could be applied during the transition period (particularly for international shipments). CSM-120 was recommended by the 5th meeting of the Transport Safety Standards Advisory Committee (TRANSSAC) in May 2000, to draft guidelines for compliance during the transition period.

The draft guidance that was authored by CSM-120 is attached (Attachment 1). The first section of the draft guidance presents recommendations (from IAEA) to national competent authorities to avoid the occurrence of safety and compliance issues during and after that nation's transition to ST-1. The two potential 'transitional' safety issues that have been identified are explained: one involving accumulation of fissile packages and one involving inadequate emergency response. Also highlighted are 'transitional' compliance issues, which do not rise to the level of safety issues, and result from the inability to concurrently comply with both revisions of the regulations. The second section of the draft guidance presents information on the notable changes in ST-1 as compared to the previous (1985, as amended 1990) version of the IAEA transport regulations (i.e., Safety Series No. 6). Also in the draft guidance is table that translates the paragraph numbers between the old and new regulations.

The CSM-120 report was provided to a Technical Committee Meeting (TC-1156.2) held at IAEA the week November 6, 2000. Mr. Lorenz presented the CSM-120 report to TC-1156.2, as Mr. Lewis had returned to the U.S. on November 4, 2000. Mr. Wangler, DOE, represented the U.S. at the TC-1156.2 working group that considered the CSM-120 report. The TCM report, which amounts to a revision and supplementation of the CSM-120 report, is also attached (Attachment 2).

At the CSM-120 wrap-up meeting, IAEA indicated that it plans to distribute the guidance to TRANSSAC members, requesting approval for expedited publication (at a minimum on the IAEA world wide web site). The expedited basis for publication was viewed as justified, because the guidance contains recommendations to national competent authorities that should be acted on before the July 1, 2001 incorporation of ST-1 into the Technical Instructions of the International Civil Aviation Organization (ICAO).

Because the U.S. DOT plans to issue rules that permit use of TS-R-1 for import/export shipment, and because the NRC and DOT have communicated the ST-1 changes to industry, the U.S. approach appears to be compatible with the primary recommendations in the draft guidance. In the opinion of the traveler, the U.S. should support IAEA efforts to publish this document. When published, it should: (1) aid in focusing attention on and maintaining safety during transition; (2) facilitate an efficient and smooth international regulatory transition; (3) increase awareness of important changes and their impacts; and (4) provide pragmatic guidance useful to a broad audience. The guidance document should be particularly useful in less-industrialized nations that have not yet focused on regulatory transition (but are part of international modal agreements), and nations that do not yet have the necessary language translations of TS-R-1 and the associated guidance (e.g., ST-2).

Attachments:

1. CSM-120
2. TCM report

The draft guidance that was authored by CSM-120 is attached (Attachment 1). The first section of the draft guidance presents recommendations (from IAEA) to national competent authorities to avoid the occurrence of safety and compliance issues during and after that nation's transition to ST-1. The two potential 'transitional' safety issues that have been identified are explained: one involving accumulation of fissile packages and one involving inadequate emergency response. Also highlighted are 'transitional' compliance issues, which do not rise to the level of safety issues, and result from the inability to concurrently comply with both revisions of the regulations. The second section of the draft guidance presents information on the notable changes in ST-1 as compared to the previous (1985, as amended 1990) version of the IAEA transport regulations (i.e., Safety Series No. 6). Also in the draft guidance is table that translates the paragraph numbers between the old and new regulations.

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Attachment 1
CSM-120

***Transitioning Arrangements
between the 1985 (As Amended
1990) and 1996 Editions of the
Transport Regulations***

The originating Section of this publication in the IAEA was:

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FOREWORD

In December 1996 the International Atomic Energy Agency published the 1996 Edition of the *Regulations for the Safe Transport of Radioactive Material* (formerly Safety Series No. 6) in a document called ST-1. That document has served as the basis for revising the UN Committee of Experts Recommendations (published in 1999 as “Model Regulations”), and as the basis for the class 7 portions of the forthcoming revisions of RID, ADR, IMO (IMDG Code), ICAO (Technical Instructions) and IATA modal dangerous goods regulations.

ST-1 was subsequently reviewed and revised with minor editorial corrections, and in 2000, a revised English version of the regulations called TS-R-1 (ST-1, Revised) was published.

Difficulties may arise when applying the Regulations during the transition between the 1985 Edition and the 1996 Edition of the Transport Regulations. These difficulties come mainly from the differences between the two regulations, for instance the definition of radioactive material with the new nuclide-specific exemption levels, the new values of A1/A2, the annual dose limits, the related documentation, the labelling requirements for fissile material package, the changes in UN numbers and proper shipping names, the shipment of fissile material by air, etc.

This TECDOC is intended to provide guidance on the implementation of changes in the *Regulations for the Safe Transport of Radioactive Material*. This guidance may be used to facilitate compliance with the Regulations.

The guidance is aimed primarily at competent authorities, but may equally be used by other users of the Regulations.

EDITORIAL NOTE

In preparing this publication for press, staff of the IAEA have made up the pages from the original manuscript(s). The views expressed do not necessarily reflect those of the IAEA, the governments of the nominating Member States or the nominating organizations.

Throughout the text names of Member States are retained as they were when the text was compiled.

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1. SCOPE

The purpose of this document is to provide guidance to competent authorities to facilitate compliance during, and after, transitioning from the previous edition of the International Atomic Energy Agency's (IAEA's) transportation regulations (Safety Series No. 6, 1985 Edition, As Amended 1990) to the 1996 editions (TS-R-1 [ST-1, Revised], in English [1]; ST-1 in French, Russian, and Spanish) of the regulations.

This guidance may also provide useful information to other users of the IAEA's transport regulations such as consignors, carriers, consignees, owners of radioactive material and package designers and fabricators.

Recommendations are made as to how compliance with regulatory requirements may be accomplished during and after the transition period. In addition, some of the important changes between the two sets of regulations are highlighted for information.

The reader is advised that there are also changes in the advisory and explanatory material presented in TS-G-1.1 compared with that in Safety Series Nos. 7 and 37. Such changes are not within the scope of this guidance document, which focuses on guidance for compliance with the regulations during transition.

Nothing in this guidance shall be construed as providing relief from national or international requirements or regulations, or the requirements of TS-R-1 and Safety Series No. 6 [2].

2. BACKGROUND

The International Atomic Energy Agency's *Regulations for the Safe Transport of Radioactive Material* are periodically updated to incorporate the latest safety information, practices and technologies related to packaging and transportation of radioactive material. The updated regulations are then incorporated into requirements of individual member States and international modal organization agreements, conventions, and requirements.

In 1996 IAEA published an updated edition of its transportation regulations, ST-1, to supersede Safety Series No. 6, the 1985 (as amended 1990) regulations (SS6). In addition, the shipment schedules, which previously appeared in a separate transport document, Safety Series No. 80, were incorporated into ST-1. In 2000, ST-1 was reissued in English to incorporate errata and to redesignate ST-1 as TS-R-1 (ST-1, Revised), in accordance with IAEA document designation practices.

Originally, a world-wide adoption date of January 1, 2001 was recommended for incorporation of TS-R-1 into modal and State requirements. Despite efforts at an international level to support a uniform implementation date, this date soon proved not to be practical. Certain modal regulatory entities have stated their intentions with respect to the timing of incorporating TS-R-1, as shown in Table 1. Individual member State intentions remain less defined, and the timing and extent of incorporation of TS-R-1 may be governed by national legislative procedures. This guidance is being issued in recognition of the importance of a

harmonized transition, to facilitate maintaining safety and avoiding unnecessary interruptions to commerce.

Table 1. Modal organization/agreement TS-R-1 adoption dates			
	ADR/RID Regulations	ICAO/Technical Instructions	IMO/IMDG code
TS-R-1 beginning	01 July 2001	01 July 2001	01 January 2001
SS6 ending	31 December 2001	30 June 2001	31 December 2001
Transition period	6 months	0	12 months

The initial dates for permitting use of TS-R-1 have been synchronized to July 1, 2001 for the cases of the ADR (European Agreement concerning the international shipment of dangerous goods by road), RID (Regulation concerning the international shipment of dangerous goods by rail), and the International Civil Aviation Organization (air mode). For land transport and sea transport (International Maritime Dangerous Goods Code of the International Maritime Organization), the beginning dates for use of TS-R-1 and the ending dates for use of SS6, are staggered, meaning that during the intervening, "transition period," either TS-R-1 or SS6 may be applied. In the case of the air mode, ICAO will not have a transition period which means that air shipments will be *required* to meet TS-R-1 at all times after July 1, 2001.

Different schedules and processes exist for each Member States' incorporation of TS-R-1 into national requirements and regulations. Because of this, and the modal organization schedules discussed above, trans-boundary shipment of radioactive materials in the near future is likely to be complicated by the need to comply with national regulatory requirements which are based upon different versions of the IAEA Transportation Regulations (i.e., SS6 and TS-R-1). In addition, a hypothetical problem could occur if one attempts to transport, by land or air with no sea component, a package that complies with TS-R-1 requirements for shipment by sea.

This document presents specific recommendations to national competent authorities (CAs). These recommendations are designed to lessen the burden of the regulatory transition and continue to facilitate safe shipment practices. In addition, notable differences between SS6 and TS-R-1 are highlighted for the CAs and for the users of the regulations. This should aid in a smooth transition to the new requirements. Principles used in developing this guidance included: (1) maintaining safety, (2) facilitating an efficient and smooth transition; (3) increasing awareness of important changes and their impacts, and (4) attempting to provide pragmatic guidance useful to a broad audience.

While this guidance attempts to remain practicable in its recommendations, it is recognized that certain recommendations, while they may be the most pragmatic solution to the issues, would require the revisions to national and international legal requirements. There is considerable uncertainty regarding the ability to accomplish the necessary agreements before July 2001. It is also not apparent that all necessary state authorities would be willing to become a party to such agreements. This is especially true in many IAEA Member States which have not yet focused on the regulatory transition, or do not yet have language

translations of the necessary documents (TS-R-1, TS-G-1.1, or the modal agreements and regulations).

3. REGULATORY TIMEFRAMES OF INTEREST

There are two periods of particular interest when incorporating the new regulations in TS-R-1: the transition period and the post-transition period. Each is further discussed in separate sections below. In addition, Section 3.3 clarifies the timeframes and conditions during which package designs based upon previous versions (SS6 and earlier versions) of the IAEA regulations can continue to be manufactured and used, in relation to the regulatory transition to TS-R-1. These provisions are found in TS-R-1 paras. 815-818.

3.1 Transition Period

For this guidance document, the term *transition period* means a fixed time period established by a competent authority or modal authority, during which the use of TS-R-1 is accepted, but not required.

During a particular competent authority's transition period, modal organization(s) or another nation(s) through which a given shipment will travel may or may not permit (or require) use of TS-R-1. The responsibility for compliance with all of the applicable regulations is that of the consignor and carrier. If each country or modal organization through which a given shipment will travel still permits transport using SS6-based regulations (even if some of the countries or modal organizations might be in a transition period that permits requirements based on TS-R-1), the easiest solution is to employ SS6 for the shipment. In other cases, to increase familiarity with the new rules, competent authorities should encourage use of the new regulations during the transition period.

For a given shipment, use of a single set of regulations during the transition period is strongly encouraged, and the set chosen should apply to the shipment from its origin through its destination. This means that a shipment made pursuant to TS-R-1 during the transition period, should comply with TS-R-1 only, and not comply with SS6 (complete, concurrent compliance with both TS-R-1 and SS6 is not possible). For example, complying with sections of TS-R-1 for certain requirements and sections of SS6 for other requirements (e.g., picking the most restrictive A_1/A_2 value for each nuclide) is a practice that should be strongly discouraged. Such practice is practically and administratively confusing and burdensome, has a high potential for actual or perceived non-compliance, and represents a possible challenge to shipment safety. As a second point, a shipment made during the transition period utilizing TS-R-1, as a matter of compliance, needs to comply with TS-R-1 - *in total*. This means that the new requirements of TS-R-1, such as radiation protection programmes, need to be in place to enable a shipment to be in compliance with TS-R-1. The practical impact of this is that, for consignor and carrier to use TS-R-1 during the transition, he or she will have had to review their programmes for compliance possibly even before the transition period begins. This is particularly important for air shipments, because ICAO does not have a transition period for the change to TS-R-1.

3.2. Post-Transition Period

After a state's transition to TS-R-1, compliance with the transport regulations can be attained through TS-R-1 only. After a state has transitioned to TS-R-1, an applicable modal organization(s) or another state(s) through which the shipment will travel, may or may not

permit (or require) use of TS-R-1. The responsibility for compliance with all of the applicable regulations is that of the consignor and carrier. The national regulations of some nations to/through which a given shipment will travel could still be based upon SS6. In practice, it is envisioned that by that time, modal organizations will implicitly already require use of TS-R-1 through their respective, compatible modal requirements. The primary recommendation of this guidance is that CA's of such nations, utilizing their internal processes, permit the use of TS-R-1, at least for import and export shipments (see section 4.1). A similar mechanism that would facilitate continued transport could be development of multi-lateral agreements to allow use of TS-R-1 for certain shipments. The importance of this recommendation is underscored because, absent such arrangements, safety issues and disruptions of commerce could manifest.

It is recommended that a state, after its transition period, disallow use of SS6 by its consignors and shippers, for export to (or import from) states which still have SS6 based regulations. This recommendation is based upon a presumption that shipments to the SS6-based state will most likely be accomplished pursuant to the modal organization requirements, which will be harmonized with TS-R-1 (or have acceptable state variances) in place at that time. (Note that the state variances to the modal requirements *could* involve 'SS6-like' provisions, but shipments would be accomplished pursuant to the modal requirements in that case and not using SS6 *per se*). Special exceptions/exemptions to the need to comply with TS-R-1 (such as Special Arrangements), or the modal requirements, after transition occurs, should not be routine practice; they should be undertaken only in extraordinary circumstances and should provide for a demonstrated equivalent level of safety.

3.3 Timeline for "Grandfathering" of previously-approved packages under TS-R-1

TS-R-1 allows for further use of approved packages under the transitional arrangements. Such transitional arrangements were incorporated also in former revisions of SS6 and in this way a set of conditions have been formulated for transitional arrangements depending on the revision of SS6 on which basis a package has been licensed. The range of transitional arrangements goes from

- 1967 SS 6 revision packages are no longer to be used.
- 1985 and 1985(90) SS 6 revision packages are allowed to be used indefinitely.

Transitional arrangements are fixed for

- the use of packages
- the manufacturing of packages
- unilateral approval
- quality assurance
- application of activity limits and restrictions
- consequences of changing the design
- marking.

The timeline for TS-R-1 based transports is illustrated in Table 2 and the transition possibilities in Table 3. Transports under the SS 6 requirements are possible through the

period of transition when both regulations are optionally applicable. For such transports under the SS 6 requirements the transitional arrangements of SS 6 are still applicable.

TABLE 2 Informational representation of TS-R-1 grandfathering provisions

SS 6 package approval basis	TS-R-1 transport	31/12/2003	31/12/2006
1967	no use		
1973 and 1973(79)	no manufacturing multilateral approval serial-number <i>QA</i> <i>activity limits and restrictions</i> <i>significant changes</i> <i>fissile air transport</i>		
1985 and 1985(90) approved packages	<i>QA</i> <i>activity limits and restrictions</i> <i>significant changes</i> <i>fissile air transport</i>	multilateral approval	no manufacturing*
1985 and 1985(90) not approved packages as not required	<i>QA</i> <i>activity limits and restrictions</i> <i>significant changes</i>	no use*	

conditions for further use; italic text: ruled by TS-R-1
*unless qualified to fulfil all TS-R-1 requirements

TABLE 3 - Transitional timing

	NOW	TRANSITION		POST TRANSITION*
		pre air	post air**	
SS 6 to TS-R-1	✓	✓	✓ ✗ air	✗
TS-R-1 to SS 6	✗	✓	✓ ✗ air	✗
SS 6 to TS-R-1	✗	✓	✓ ✗ air	✗
TS-R-1 to TS-R-1	✗	✓	✓	✓

*depends on Member States **after 01/07/2001

✓ possible
✗ impossible

grey: state must have transitional arrangements commencing before mandatory air mode regulations change; shipment under special arrangement, or multilateral agreements to use TS-R-1 incorporated into SS 6 state requirements.

4. RECOMMENDATIONS

This section presents guidance in the form of recommendations to competent authorities. The guidance focuses on actions that should become necessary as a result of the world-wide transition to TS-R-1 at different times.

The principles used in making the recommendations are: (1) safety should not be compromised as a result of transitioning regulations; (2) a given shipment should be made all the way from consignor to consignee under (i.e., in compliance with) a single set of regulations (based on SS6 or based on TS-R-1), regardless of whether the shipment is domestic, international or multi-modal; (3) any guidance, if followed, should not lead to non-compliance with the regulations in any state or mode with authority over the shipment; (4) guidance should express preference for the simplest solution, provided an equivalent level of safety is retained.

4.1 Primary Recommendations

- 4.1.1 Each competent authority should act to permit use of TS-R-1, at least for certain shipments, by 01 July 2001.

Each competent authority should assess their TS-R-1 adoption date (and transition period, if one is planned) against the dates to be employed in the modal regulations (see Table 1) that concern shipment to, from, and within that CA's nation.

If a competent authority determines that TS-R-1 will not be incorporated by the date to be used by an applicable modal organization, the competent authority is strongly encouraged to provide an alternative solution such as the use of regulatory substitutions or multilateral agreements:

- Permitting the use of TS-R-1 itself or TS-R-1 based modal requirements, for import, export and transboundary movement of Class 7 materials. This can be achieved, for example, through a change to its national regulatory infrastructure or exemption process. [This guidance presumes that such changes might be accomplished in a more timely manner than complete harmonization of domestic requirements with TS-R-1.] Note that in this case, TS-R-1 requirements as embodied in the modal regulatory provisions, could substitute for the existing (e.g., SS6-based) national requirements only for shipments where such substitution is necessary (those where modal requirements based on TS-R-1 would apply) and possibly only until such time as the domestic regulations are harmonized with TS-R-1. Examples of this approach can be found in the domestic regulations of the United States, U.S. Code of Federal Regulations Title 49 Part 171, Section 11 (permits use of ICAO Technical Instructions) and Section 12 (permits IMDG code and IAEA regulations).
- Entering into multi-lateral agreements. A multi-lateral agreement, pursuant to certain modal regulations, could also be used allow derogation of certain requirements that would otherwise apply to a shipment. This recommendation assumes that the national requirements already permit the use of the applicable modal organization requirements (and the permission would remain in place after those modal requirements become TS-R-1-based). However, practical problems

need to be acknowledged regarding obtaining approval (potentially by many states and in many languages) of the agreement through the modal organization. The following text, provided for information, is an example of a draft multi-lateral agreement.

1. Packages of Class 7 material, including intermediate bulk containers (IBC), freight containers and tanks, which do not entirely comply with the prescriptions relating to materials, packaging, or hazard communications (marking, labeling, placarding, and shipping papers) of the [SS-6 based national requirements], but which otherwise comply with the parallel prescriptions in [the relevant modal requirements, or TS-R-1], may be shipped to [nation(s) which has (have) incorporated TS-R-1 into their national requirements].
2. [Additional conditions and restrictions of approval, as appropriate.]
3. This multilateral agreement is applicable from 01 July 2001 through [date of TS-R-1 incorporation in SS-6-based nation(s)] and [other condition\ as appropriate]....

4.1.2 Each competent authority who permits use of TS-R-1 should facilitate prompt communication of particular changes and training

To the extent practicable, each competent authority is strongly recommended to take proactive steps to inform its users (including consignors, carriers, consignees, package designers, fabricators, emergency responders) of the pending changes in regulations, paying particular attention to the safety issues highlighted in section 4.2 of this document. Generic letters to licensees and certificate holders could be one means of accomplishing this communication. The information in section 5 of this document could provide the basis. However, it is recognized that communication to all interested parties is difficult in many countries.

Many countries use emergency response guides for first responders, that are keyed to UN identification numbers or proper shipping names. Updating or supplementing these guides is one possible way to provide relief from the potential for misunderstanding after an accident involving packages transported under the new requirements.

If shipments are expected that utilize regulations based on TS-R-1, training received by transportation workers and emergency responders should be supplemented prior to such shipments. Failure to do so introduces a potential for improper package handling or emergency response during transport, due to a misunderstanding of the changed package handling requirements and marking, labeling, placarding, and shipping paper requirements. See section 4.2. The IAEA has training material associated with the changes in the regulations that could be freely distributed to aid in this effort.

The recommendation that competent authority facilitate communication and training on the upcoming regulatory changes is particularly important when considered in conjunction with the recommendation above for early permission of use of TS-R-1 on imports, exports, and transboundary shipments in countries whose domestic harmonization with TS-R-1 will be delayed. For example, if a nation with SS6-based regulations were to permit use of TS-R-1 packages on an air import, the transportation workers or emergency responders that encounter the package might not be familiar with the hazard communications (e.g., the marked UN identification number) they encounter.

Competent authorities should also attempt to identify methods to notify previously non-regulated entities, who may become subject to the regulations based on TS-R-1, as a result of the changes to the exempt concentrations and consignment limits and the changes in scope (see section 5.1 and 5.13.5).

4.1.3 Competent authorities should further focus their compliance assurance efforts on safety issues, immediately after transitioning to TS-R-1

Successfully implementing and complying with the changes implemented in TS-R-1 is likely to involve a learning process by both the regulators and the users of the regulations.

Immediately after the transition to TS-R-1, it is recommended that a CA's compliance assurance measures take steps to be particularly mindful of the possible implications to transport safety of practices that are adopted (including but not limited to violations of the requirements). Emergent issues of potential safety significance could manifest that involve continuation of past practices, differing interpretations of the new regulations, or violations of the requirements. Safety issues that are identified should be promptly communicated to IAEA to support additional dissemination of that information.

In addition, a particular competent authority may wish to tailor its enforcement strategy to acknowledge the regulatory familiarization period. This approach would recognize that many issues with complying with TS-R-1 as compared to SS6 are of very little or no safety significance. Users should be assisted (to the extent appropriate) and encouraged to promptly institute corrective actions of violations or weaknesses.

4.2 Potential Safety Issues

This section discusses the potential safety issues, that have been identified, associated with the transition to TS-R-1. To avoid the occurrence of these hypothetical safety issues, each competent authority, as part of the recommendation in section 4.1.2, should facilitate communication of and training on this information. In this guidance, the term *safety issue* means an issue that represents a possible event occurring and resulting in a fair hazard to the transportation worker or public safety and health. Most non-compliance events that can be envisioned as a direct consequence of the SS6 to TS-R-1 transition would not be safety issues, but rather compliance (e.g., administrative) issues; for example, failure to comply with the TS-R-1 radionuclide specific exemption values

as compared to the SS6 70 Bq/g value, appears to have little relevance to safety significance due to the potential radiological exposure that might occur.

4.2.1 Potential for improper package accumulation (separation of CSI from the TI)

If a fissile package, that is transported based on TS-R-1 requirements, arrives in a location that is using SS6-based regulations, a transport worker might not understand the CSI and fissile label (which are newly introduced). Because package accumulation in transit (based on nuclear criticality considerations), is controlled by either: (1) limits on the total TI under SS6, or (2) limits on the total CSI under TS-R-1; the worker could inadvertently place packages together in violation of TS-R-1 para. 569. This could represent a potential nuclear criticality hazard. [Note: A SS6 based country was used as the likely example, but is not a prerequisite. The above situation could occur even in a country that *has* transitioned to TS-R-1, if the issue is not adequately communicated, and training provided, down to the transport worker level.]

- *To further illustrate the above, the following example is given: Package X is an SS6 package with a TI of 10; based on a value of 1 for radiation safety and 10 for criticality safety). It is labelled and marked on the label with a TI=10. Package Y is identical but based on TS-R-1. It has a TI of 1 and CSI of 10. It has two labels, the traditional label showing a TI of 1 and the newly introduced fissile label showing a CSI of 10. In order to assure safety, both SS6 and TS-R-1 would require no more than 5 of these packages be grouped (total TI of 50 under SS6, or total CSI of 50 under TS-R-1). However, a transport worker experienced only with SS6 might well group 50 of Package Y together.*

In a converse situation, if a fissile package, that is based on SS6 requirements, arrives in a location that is using regulations based on TS-R-1, a transport worker might mistakenly believe that the TI on that package is not related to criticality control (that package would not have a CSI or fissile label if shipped per SS6). As a result, the worker could inadvertently store or load that package together with other fissile packages - be they based on SS6 or TS-R-1 - representing a potential nuclear criticality hazard.

There does not appear to be a shipping practice that could entirely eliminate the potential for these occurrences. The labeling of SS6 shipments with the fissile label and showing a CSI may be non-compliant with SS6 based rules that the shipment was made under, violates a principle of this guidance to use one set of regulations entirely, and also does not appear to sufficiently resolve either of the above situations.

Therefore, the recommendation to avoid this issue is twofold: (1) CA's should advise consignors of fissile material to notify the carriers (e.g., using special instructions) of their fissile consignments of this problem; (2) CAs should encourage communication of this issue and training appropriate to the level of the transport workers. Specifically, handlers should be trained to concurrently use the criticality aspects of the TI based upon SS6, and the radiation safety aspects of the TI and criticality safety aspects of the CSI in TS-R-1. As the community of users

of fissile radioactive material is generally well known and regulated to a greater extent, this communication should be feasible.

4.2.2 Potential for Inadequate Emergency Response due to unfamiliar hazard communications (UN Number and Proper Shipping Names)

If a package, that is transported based on TS-R-1 requirements, arrives in a location that is using SS6-based regulations, a transport worker or emergency responder after an accident might not recognize the UN Identification Number and Proper Shipping Name. This has the potential of resulting in inadequate emergency response actions, as the UN ID No. is sometimes used by the first responder, in conjunction with emergency response guidance, to identify the appropriate immediate protective and mitigative actions. However, it is noted that the proper shipping name is required to be marked on TS-R-1 package and will include the terms, "RADIOACTIVE MATERIAL,..." and "...FISSILE...", as appropriate. This fact should help reduce the potential significance of this issue, as at least the hazard class of the material would be apparent and could be correlated to previous emergency response guidance.

The recommendation to avoid this issue is for CAs to update the applicable emergency response guidance, and also to follow the communications recommendations of section 4.1.2.

4.3 Potential Compliance Issues

This section identifies and makes recommendations to competent authorities relating to possible issues of non-compliance, caused by regulatory transition, that are not considered in themselves to be safety issues.

4.3.1 New Flux / Dose Equivalent Rate Conversion Factors

It is recommended that transports under TS-R-1 during the transition period comply with the dose rate limits measured according to the new dose quantities irrespective to the transitional arrangements concerning package approval. Using quantities is also mandatory for TS-R-1 regulated transports in the post transition period. With respect to the allowed contents of a package based on a former approval on the basis of the old dose quantities there is no immediate need for a renewed assessment of the dose rate calculations and subsequently no immediate need for a revision of the certificate of package approval. The necessary dose rate measurements before any shipment, which are based on the new quantities, will ensure that no violation of the dose rate limits will occur.

On the other hand the consignor should assess before loading of packages whether the transfer to the new dose quantities has the potential of reaching dose rate levels in excess of the limits. The overall practice of loadings shows that packages normally are not loaded up to the maximum contents which is fixed in the package approval certificate. However, there might be situations in which this will be the case and for those situations, unloading a loaded package after the measurement has demonstrated a too high dose rate level should be avoided for radiation protection reasons.

It should be noted that any dose rate measurement made in accordance with the older flux-to-dose conversion factors, revealing a dose rate level of less than 2/3 of the limit, has, *per se*, no capability of leading to excessive dose rates. The maximum factor for the transfer from the old dose quantities to the new ambient dose equivalent is 1.5 irrespective of the kind of radiation and its energy range.

New package approvals to be issued in the time period when both SS6 and TS-R-1 are optionally valid should be issued on the basis of TS-R-1 requirements. This means with respect to dose rate calculations that the new dose quantities have to be applied in the safety assessment analysis.

4.3.2 Development and introduction of Radiation Protection Programme

The existence of a radiation protection programme is one of the new requirements of TS-R-1 compared to the earlier versions of the transport regulations. Therefore, a transport under the provisions of TS-R-1 necessarily requires a radiation protection programme to be established. The elements of a radiation protection programme may differ substantially, according to the nature and number of transports, and their radiological significance. Special advice on the contents and the recommended elements of a radiation protection programme is given in IAEA TECDOC XXXX [4]

4.3.3 Changes in A Values

A values have changed for certain radionuclides. The changes for many radionuclides are rather limited, with most values within a factor of three of the earlier ones. There are no A_1 or A_2 values lower than the previous figures by more than a factor of 10. Most of the A values for important, often transported radionuclides remain unchanged. Package safety analysis reports or design justifications need not be automatically reviewed where a competent authority has addressed the issue generically and shown there to be no safety problem, as in most cases there is a large margin of safety. This is true for packages which will be used under the transitional arrangements of TS-R-1.

New package design justifications and approvals should explicitly consider the revised A values, even during the transition period.

The change of A values has to be taken into account when considering package and material activity limits and restrictions. There may, in some cases, where the change of A values leads to a change in packaging requirements (e.g. excepted quantities of radioactive material under SS6 may become type A quantities under TS-R-1 and type A quantities of radioactive material under SS6 may become type B quantities under TS-R-1). This is a known issue, where certain radiopharmaceuticals despatched in single patient doses in excepted packages under SS6 will require type A packages under TS-R-1 for the same level of activity.

It is therefore important that this message is communicated to the users of the transport regulations by the competent authorities.

4.3.4 Uranium Hexafluoride packages

There are new requirements in TS-R-1 for packages containing uranium hexafluoride which are of particular concern where non-fissile or fissile excepted UF₆ is to be transported. Section 5.13.4 summarises the new requirements, which also apply to all approved package designs for fissile UF₆. However, it should be noted that the requirements of TS-R-1 paragraphs 630 - 632 inclusive do not apply to fissile UF₆ packages, since the requirements in TS-R-1 for fissile material are either equivalent or more severe. Therefore, approved package designs may continue to be used *subject to the provisions of ISO 7195*.

4.3.5 Fissile Material shipments by air

For shipment of fissile material by air, TS-R-1 requires that packages with quantities greater than excepted amounts require an additional criticality evaluation during certification (see section 5.13.3). Packages must remain subcritical, assuming 20 centimetres water reflection but not in-leakage (i.e., moderation) when subjected to the tests for Type C packages (see Issue 6). The specification of no water ingress is given as the objective of this requirement is protection from criticality events resulting from mechanical or physical rearrangement of the geometry of the package (i.e., fast criticality). Note that the application of the paragraph 680 requirement to fissile-by-air packages is in addition to the normal condition tests and accident tests that the given package already must meet.

Certain factors need to be considered in determining the practical impacts of domestic adoption of TS-R-1 paragraph 680. First, all uranium can be shipped in non-Type C package (IF, AF) due to its A₁ and A₂ values. The paragraph 680(a) requirements appear to be readily satisfied by low-enriched uranium, because low enriched uranium (less than approximately 5% enrichment) would typically require moderation (e.g., by water) to achieve nuclear criticality, but the test specifies no water ingress. This lends itself to a potential generic solution (possibly by the competent authority or an industry group) for air transport of low enriched uranium packages that do not contain moderating material as part of the contents or packaging.

This guidance also recommends that CA's consider the need to revise each certificate for fissile material packages to include a condition showing an expiration date for air transport of 30 June 2001. This date is the ICAO adoption date, and note that because there is no ICAO transition period (see Table 1), this issue needs to be resolved to satisfaction prior to 30 June 2001.

4.3.6 Hazard Communications

Marking, labelling, placarding and transport documentation have changed. Of particular note is the introduction of 25 new or revised UN numbers, which must be marked on the outside of every package and on the transport documents. An overview of the details of the changes are presented in sections 5.8 and 5.9 of this

TECDOC. It is therefore important that these changes are communicated by the competent authority to the users of the Regulations.

Competent authorities must be notified of shipments of type C packages containing $>3000 A_1$ or $>3000 A_2$, as appropriate, or 1000 TBq, whichever is the lower.

4.3.7 Quality Assurance requirements for Grandfathered packages / materials

For packages approved by the competent authority under the 1973 or 1973 (As Amended) editions of Safety Series No. 6, TS-R-1 paragraph 816 states that such packages may continue to be used subject to "...the mandatory programme of quality assurance in accordance with the *applicable* requirements of para. 310;...".

For special form radioactive material manufactured to a design approved by the competent authority under the 1973, 1973 (As Amended), 1985 or 1985 (As Amended 1990) editions of Safety Series No. 6, TS-R-1 paragraph 818 states that such material may continue to be used when in compliance with "the mandatory programme of quality assurance in accordance with the *applicable* requirements of para. 310."

Competent Authorities should ensure that these "applicable" requirements are defined and that users are informed accordingly.

4.3.8 Exempt shipments

The definition of the exemption values in TS-R-1 have changed from the 70 Bq g^{-1} limit applied to all radionuclides in SS6, to a combination of radionuclide specific activity concentration together with a radionuclide specific activity limit per consignment. For the material to be considered radioactive under TS-R-1, both the specific activity limit and the consignment limit must be in excess of the values given.

There are situations where the TS-R-1 exemption values are above the 70 Bq g^{-1} criterion of SS6 for certain radionuclides, and below the SS6 criterion for others. The new exemption values of TS-R-1 are based on detailed dose assessments, based upon a dose uptake to critical groups of occupational workers of $10 \mu\text{Sv yr}^{-1}$. Hence the limits imposed ensure that there is no radiological hazard either to people involved in the transport or to people that may otherwise be exposed.

The advantage of the new exemption values is that they are harmonised with those recommended by the Basic Safety Standard [3] for radiation protection purposes. competent authorities can therefore be encouraged to tolerate the new exemption values irrespective of the fact that for a transition period, the new exemption values may be for certain shipments higher than the SS6 based regulation would allow.

4.3.9 Material restrictions on air shipments

TS-R-1 introduces activity limits for shipment by air.

The maximum activity allowed in a single industrial package containing non-combustible solid LSA-II or LSA-III material for shipment by air is 3000 A₂.

The maximum activity allowed in a single type B package for shipment by air is 3000 A₁ (but not greater than 10⁵ A₂) for material as special form, and 3000 A₂ for material not as special form, unless the package contains competent authority approved low dispersible material (LDM) in approved quantities.

It is recommended that competent authorities consider revising all certificates of approval where the air mode quantity restrictions apply, to show an expiration date of 30 June 2001.

LDM must be of a limited radiological hazard and meet a range of specified impact, thermal and leaching tests. Multilateral Competent Authority approval of the LDM is required (with a new approval certificate type code "LD"), and type B(U) package designs for the carriage of LDM also require multilateral Competent Authority Approval.

Material with an activity above the limits presented above must be transported in a new package type - the type C package. Type C packages must withstand an enhanced series of regulatory tests (impact, puncture, dynamic crush, thermal and immersion) and require unilateral competent authority approval, except where the contents are fissile, in which case multilateral approval is required. The contents and activity limits of type C package are authorised by the competent authority.

5. NOTABLE CHANGES

This section presents information on the notable differences between Safety Series No. 6 and TS-R-1, and is intended to be of equal value to both competent authorities and other users of the Regulations.

The following points are categorized similarly to the schedules of requirements included in TS-R-1. This list is probably not exhaustive, but represents the most important changes. As such the user should satisfy themselves that all changes relevant to their particular situation have been identified and addressed.

N.B. TS-R-1 requires the use of SI units throughout.

5.1 Materials

- ◆ *Radioactive material has been redefined - radionuclide dependent material specific activity exemption limits and exempt consignment activity limits are introduced in TS-R-1*
- ◆ *As a result of the definition of radioactive material changing, with radionuclide dependent material specific activity exemption limits and exempt consignment activity in TS-R-1, materials which were previously not defined as radioactive under Safety Series No. 6 may be defined as radioactive under TS-R-1, and vice versa.*
- ◆ *TS-R-1 contains revised A_1 and A_2 values (including lung absorption types for Uranium). Not all have changed, but some of the changes are significant.*
- ◆ *Materials that exceed the exempt activity concentration by more than 10 times, but less than 30 times, by consignment, may be transported as LSA-I provided they are not fissile or are fissile excepted. LSA-I material may be transported unpackaged or in bulk, but there must be no escape of material from the conveyance during routine transport*
- ◆ *The consequences of revised A values for materials are new LSA values and new release limits for LSA-III*
- ◆ *The LSA-III material definition specifically excludes powders in TS-R-1*
- ◆ *Low Dispersible Radioactive Material (LDM) is introduced in TS-R-1. LDM must be of a limited radiological hazard and meet a range of specified impact, thermal and leaching tests. Multilateral Competent Authority approval is required, with a new approval certificate type code "LD". Type B(U) package designs for the carriage of LDM require multilateral Competent Authority Approval.*
- ◆ *For Special Form radioactive material, a 200g mass limit exemption from the TS-R-1 bending and percussion tests has been introduced, providing specimens are alternatively subjected to the Class 4 impact test specified in ISO2919, and from the TS-R-1 heat test providing specimens are alternatively subjected to the Class 6 temperature test specified in ISO2919.*
- ◆ *The definition of unirradiated Uranium has been amended in TS-R-1*
- ◆ *Revised transitional arrangements mean that Special Form radioactive material approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) regulations may continued to be manufactured and used until 31.12.2003, but with TS-R-1 Quality Assurance (QA) requirements. Special Form radioactive material*

approved under other than the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) editions of the regulations is no longer allowed under TS-R-1.

5.2 Packaging

- ◆ *The consequences of revised A values for packages include new activity limits for excepted packages and new release limits for Type B and Type C packages after testing*
- ◆ *The alternative requirements for IP-2 and IP-3 packages allowed in TS-R-1 are more stringent - IP-2 must meet UN packing group I or II requirements; freight containers used as IP-2 or IP-3 packages are only allowed to carry solid radioactive material; only metallic Intermediate Bulk Containers (IBCs) are allowed, and IBCs must be tested in the most damaging orientation*
- ◆ *Package contents limitations for Industrial & Type B packages by air have been introduced in TS-R-1. Non-combustible solid LSA-II or LSA-III is limited to $\leq 3000 A_2$ per package. Type B packages are limited to carrying material with an activity $\leq 3000 A_1$ or $\leq 10^5 A_2$ as special form, whichever is the lower; $\leq 3000 A_2$ not as special form; or approved LDM.*
- ◆ *Type C Packages for shipment of quantities of radioactive material prohibited in other packages have been introduced in TS-R-1. Competent Authority approval is required, with a new approval certificate type code "C".*
- ◆ *Pressure and temperature requirements for all packagings - the design shall take into account ambient temperatures and pressures likely to be encountered in routine conditions of transport and the containment system shall retain the radioactive contents under a reduction in ambient pressure to 60 kPa (unless being transported by air when the containment system shall retain the radioactive contents under a reduction in ambient pressure to 5 kPa).*
- ◆ *The enhanced water immersion test (200m for one hour) previously reserved for packages containing irradiated nuclear fuel has been extended to all Type B packages containing $>10^5 A_2$, and all Type C packages in TS-R-1*
- ◆ *Revised transitional arrangements mean that, for non competent authority approved packages, manufacture is allowed until 31.12.2003 but with TS-R-1 package QA, activity limits and material restrictions. Such packages prepared for transport not later than 31.12.2003 may only be consigned once after this date. Any subsequent consignment must meet TS-R-1 requirements in full.*

For packages approved by competent authorities under the 1973 and 1973 (As Amended) regulations, further packaging manufacture is not allowed and use of existing packages is only permissible with multilateral approval, TS-R-1 appropriate QA, activity limits, material restrictions and criticality restrictions for transport of fissile material by air (if appropriate).

For packages approved by competent authorities under the 1985 and 1985 (As Amended 1990) regulations, manufacture is allowed until 31.12.2006. Packages may be used until 31.12.2003 but with TS-R-1 QA, activity limits, material restrictions and criticality restrictions for transport of fissile material by air (if appropriate). Multilateral approval shall be required from 01.01.2004.

Packages approved under other than the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) editions of the regulations are no longer allowed under TS-R-1.

5.3 Maximum Radiation Levels

◆ *No notable regulatory changes*

5.4 Contamination

- ◆ *Contamination limits have been harmonised for all package types*

5.5 Decontamination and Use of Conveyances

- ◆ *No notable regulatory changes*

5.6 Mixed Contents

- ◆ *No notable regulatory changes*

5.7 Loading and Segregation

- ◆ *In TS-R-1, the Transport Index is used solely for radiation control. A new index, the criticality safety index (CSI) is used for criticality control. The CSI effectively replaces the TI for criticality control used in Safety Series No. 6. There is no requirement for separation distances in the TS-R-1 Transport Index table (Table IX). These are now presented in the TS-R-1 CSI table (Table X). The limit on the sum of Transport Index and the limit on the sum of CSI on a conveyance are not necessarily the same.*

5.8 Labelling and Marking

- ◆ *New non competent authority approved package external marking requirements are presented in TS-R-1. The package must be legibly and durably marked with an identification of the consignor or consignee, or both; Excepted packages must be legibly and durably marked with "UN" and the new UN number; All other non competent authority approved packages must be legibly and durably marked with "UN", new UN number and proper shipping name (PSN); Industrial Packages must be marked with "TYPE IP-1" (or IP-2 or IP-3, as appropriate); Type A packages must be marked with "TYPE A"; IP-2, IP-3 and Type A packages must be marked with the vehicle registration identification (VRI) code and the name of packaging manufacturer, or other identification of the packaging specified by the Competent Authority*
- ◆ *New competent authority approved external package marking requirements are presented in TS-R-1. The package must be legibly and durably marked with "UN"; the new UN number and proper shipping name; and an identification of the consignor or consignee, or both. Type B and Type C packages must be marked with "TYPE B(U)", "TYPE B(M)", or "TYPE C", as appropriate and a fire / water resistant trefoil symbol.*
- ◆ *TS-R-1 presents 25 new or revised UN numbers, proper shipping names and descriptions. All proper shipping names begin "RADIOACTIVE MATERIAL". Where UN numbers have been retained, the actual scope may be different from Safety Series No. 6.*
- ◆ *For fissile packages, Safety Series No. 6 required that the category label show the higher of the transport index for radiation exposure control and the transport index for nuclear criticality control. TS-R-1 effectively splits this into two separate labels. The Transport Index (formerly the transport index for radiation exposure control) continues to be marked on the category label (II Yellow or III Yellow, as appropriate).*

Packages containing fissile material must also be labelled with a criticality safety index (CSI) label. The CSI label must show the CSI (formerly the transport index for nuclear criticality control) for the package.

- ◆ *TS-R-1 allows the trefoil symbol on category labels to be slightly smaller than under Safety Series No. 6.*

5.9 Placarding

- ◆ *TS-R-1 allows smaller placards (minimum side dimension = 100mm) to be used where vehicles have insufficient area to allow the fixing of larger placards, and allows the trefoil symbol on placards to be slightly smaller than under Safety Series No. 6.*
- ◆ *TS-R-1 presents 25 new or revised UN numbers, proper shipping names and descriptions. All proper shipping names begin "RADIOACTIVE MATERIAL". Where UN numbers have been retained, the actual scope may be different from Safety Series No. 6.*

5.10 Transport Documents

- ◆ *TS-R-1 presents 25 new or revised UN numbers, proper shipping names and descriptions. All proper shipping names begin "RADIOACTIVE MATERIAL". Where UN numbers have been retained, the actual scope may be different from Safety Series No. 6.*
- ◆ *Consignment documents for LSA-II, LSA-III, SCO-I and SCO-II must show the total activity of the consignment as a multiple of A_2 .*

5.11 Storage and Dispatch

- ◆ *No notable regulatory changes*

5.12 Carriage

- ◆ *As a result of the definition of radioactive material changing, with radionuclide dependent material specific activity exemption limits and exempt consignment activity in TS-R-1, materials which were previously not defined as radioactive under Safety Series No. 6 may be defined as radioactive under TS-R-1, and vice versa.*
- ◆ *As a consequence of the revised A values presented in TS-R-1, there are new conveyance limits for LSA / SCO*
- ◆ *Packages used for the transport of radioactive material by air must have a containment system capable of retaining the radioactive contents under a reduction in ambient pressure to 5 kPa. This requirement applies to all package types (including excepted), and material phases*
- ◆ *Consignment mass limits are introduced for exceptions from the requirements for packages containing fissile material.*
- ◆ *Competent Authorities must be notified of shipments of Type C packages containing >3000 A_1 or >3000 A_2 , as appropriate, or 1000 TBq, whichever is the lower*

5.13 Other Provisions

5.13.1 Radiation Protection Programme

- ◆ *Radiation Protection Programmes are explicitly required by TS-R-1 (with auditable documentation) to cover design, manufacture, inspection maintenance and repair, preparation, consigning, loading, carriage, storage in transit, unloading and receipt. The revised Basic Safety Standard sets a 20 mSv annual exposure limit (averaged over 5 years), with a maximum of 50 mSv in any one year.*

5.13.2 Quality Assurance and Compliance Assurance for Special Form and Low Dispersible Radioactive Material

- ◆ *The requirement for Quality Assurance and Compliance Assurance for Special Form and Low Dispersible Radioactive Material (LDM) has been explicitly added in TS-R-1.*

5.13.3 Transport of Fissile Material

Fissile Material and Design Requirements have changed in TS-R-1.

- ◆ *Revisions to the exceptions from the requirements for packages containing fissile material allow only one type of exception per consignment, and introduce mass limits per consignment, together with other minor changes.*
- ◆ *The definition of LSA-I material specifically allows for the presence of fissile material in excepted quantities*
- ◆ *Pu238 is no longer considered fissile for the purposes of TS-R-1*
- ◆ *Escape of material from damaged containment systems in non Competent Authority approved packages is covered explicitly in TS-R-1*
- ◆ *A new definition, that of the "Confinement system", is introduced. This is the assembly of fissile material and packaging components specified by the designer and agreed to by the Competent Authority as intended to preserve criticality safety*
- ◆ *For air shipments, the "Type B" assessment conditions relating to a single package must not take into account water barriers unless the water barriers have been proven to withstand the Type C test requirements without leakage*
- ◆ *When taking account of irradiation of nuclear fuel (burnup credit) in a criticality safety case, pre shipment (post irradiation) measurement is required to confirm the conservatism of the assumed isotopic composition*
- ◆ *For the transport of fissile material by air, the system must be shown to remain safely subcritical under conditions consistent with the tests for Type C packages but assuming no water in-leakage*
- ◆ *A dynamic crush test is required for low density, lightweight packages containing fissile material*
- ◆ *An operating temperature range of -40 °C to +38 °C is explicitly stated in TS-R-1 for all fissile packages*

- ◆ *The requirement in Safety Series No. 6 for a free drop test from a height of 0.3m on each corner (or onto the quarters of each rim for a cylindrical package) is deleted in TS-R-1*
- ◆ *When formulating the criticality safety case, TS-R-1 does not require the examination of the containment system in isolation if the confinement system remains within the package*

5.13.4 Transport of Uranium Hexafluoride

- ◆ *Packages containing >0.1kg UF₆ must not be fitted with pressure relief devices, will require Competent Authority approval and must withstand without leakage an internal hydraulic pressure test of 1.38 MPa (those withstanding less than 2.76 MPa require multilateral approval); a 0.3m – 1.2m drop test (depending on the mass of the package) and an 800 °C thermal test for 30 minutes (multilateral approval is required for packages >9000kg not withstanding the thermal test)*
- ◆ *Packages must meet the requirements of ISO7195 (or equivalent requirements, as agreed with the competent authority), together with the TS-R-1 requirements regarding the radioactive and fissile properties of the material to be transported.*
- ◆ *Where a design requires multilateral approval, certification will be required from 01.01.2002, unless by air. Where a design requires unilateral approval, certification will be required from 01.01.2004.*
- ◆ *Where fissile UF₆ is being transported, the fissile requirements of TS-R-1 must be met with no contact between valves and other normally non-contacting parts, and no leakage from the valve.*
- ◆ *New competent authority approval certificate type codes “H(U)” and “H(M)” for non-fissile or fissile excepted UF₆ packages requiring unilateral or multilateral competent authority design approval respectively*

5.13.5. Scope

- ◆ *The scope of applicability of TS-R-1 no longer includes consumer products after sale to an end user or the transport of live animals after treatment with radioisotopes*
- ◆ *Transport, comprising all operations and conditions associated with and involved in the movement of radioactive material, has been extended to specifically include the repair of packaging.*

5.13.6 Special Arrangement

- ◆ *The definition of Special Arrangement has been changed in TS-R-1*

7. REFERENCES

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, Safety Standards Series No. TS-R-1 (ST-1, Revised), 1996 Edition (Revised), IAEA, Vienna (2000)
- [2] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, Safety Series No. 6, 1985 Edition (As Amended 1990), IAEA, Vienna (1990)
- [3] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996)
- [4] INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection Programmes for the Transport of Radioactive Material, TECDOC XXXX, IAEA, Vienna (2001)

8.1 Translation of paragraph numbers between Safety Series No. 6 and TS-R-1

SS6	TS-R-1
-	102
-	104
-	209
-	218
-	224
-	227
-	234
-	301
-	302
-	303
-	305
-	412
-	414
-	416
-	417
-	529
-	534
-	535
-	540
-	544
-	545
-	615
-	615
-	628
-	667
-	668
-	669
-	670
-	675
-	677
-	678
-	679
-	681
-	682
-	734
-	735
-	736
-	737
-	801
-	629
-	630
-	630
-	632
-	631
-	718
-	419

SS6	TS-R-1
-	419
-	802
-	828
-	225
-	605
-	663
-	676
-	680
-	712
-	712
-	712
-	805
-	815
-	818
-	620
-	624
-	110
101	101
102	106
103	107
104	108
105	109
107	105
108	103
109	-
110	201
111	202
112	203
113	204
114	205
115	206
116	207
117	208
118	210
119	211
120	212
121	213
122	214
123	216
124	215
125	217
126	219
127	220
128	221
129	222
130	223

8.1 Translation of paragraph numbers between Safety Series No. 6 and TS-R-1

SS6	TS-R-1
131	226
132	228
133	229
134	230
135	231
136	232
137	233
138	235
139	236
140	237
141	238
142	239
143	240
144	241
145	242
146	243
148	244
149	245
150	246
151	247
152	248
203	304
205	306
206	307
207	308
208	309
209	310
210	311
211	312
301	401
302	402
303	403
304	404
305	405
306	406
307	407
308	408
309	409
310	410
311	411
312	413
313	415
314	-
315	418
401	501
402	502

SS6	TS-R-1
403	503
404	504
405	505
406	506
407	507
408	508
409	509
410	510
411	511
412	512
413	513
414	514
415	515
416	516
417	-
418	517
419	518
420	519
421	520
422	521
423	522
425	523
426	524
427	525
428	526
429	528
430	527
432	530
433	531
434	532
435	533
436	536
437	537
438	538
439	539
440	541
441	542
442	543
443	546
444	547
445	-
446	548
447	549
448	550
449	551
450	552

8.1 Translation of paragraph numbers between Safety Series No. 6 and TS-R-1

SS6	TS-R-1
451	553
452	554
453	555
454	556
455	557
456	558
457	559
458	560
459	561
460	562
461	563
462	564
463	565
465	566
466	567
467	570
468	571
469	572
470	573
471	574
472	575
473	576
474	577
475	578
476	579
477	580
479	568
480	569
483	581
484	582
501	601
502	602
503	603
504	604
505	606
506	607
507	608
508	609
509	610
510	611
511	612
512	613
513	614
514	616
515	617
516	618

SS6	TS-R-1
517	619
518	621
519	622
520	623
521	625
522	626
523	627
524	633
525	634
526	635
527	636
528	637
529	638
530	639
531	640
532	641
533	642
534	643
535	644
536	645
537	646
538	647
539	648
540	649
541	650
542	656
543	651
544	652
545	653
546	654
547	655
548	656
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551	658
552	659
553	660
554	661
555	662
556	664
557	665
558	666
559	671
560	672
562	671
568	674
568	673

8.1 Translation of paragraph numbers between Safety Series No. 6 and TS-R-1

SS6	TS-R-1
601	701
602	702
603	703
604	704
605	704
606	704
607	705
608	706
609	707
610	708
611	709
612	710
613	711
614	713
615	714
616	715
617	716
618	717
619	719
620	720
621	721
622	722
623	723
624	724
625	725
626	726
627	727
628	728
629	729
630	730
631	731
632	732
633	733
701	802
702	803
703	804
704	806
705	807
706	808
707	809
708	810
709	811
710	812
711	813
712	814
713	816

SS6	TS-R-1
714	817
715	819
716	820
717	821
718	822
719	823
720	824
721	825
722	826
723	827
724	828
725	829
726	830
727	831
728	832
729	833
730	834

8.2 Translation of paragraph numbers between TS-R-1 and Safety Series No. 6

SS6	TS-R-1
109	-
314	-
417	-
445	-
101	101
-	102
108	103
-	104
107	105
102	106
103	107
104	108
105	109
-	110
110	201
111	202
112	203
113	204
114	205
115	206
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121	213
122	214
124	215
123	216
125	217
-	218
126	219
127	220
128	221
129	222
130	223
-	224
-	225
131	226
-	227
132	228
133	229
134	230
135	231
136	232

SS6	TS-R-1
137	233
-	234
138	235
139	236
140	237
141	238
142	239
143	240
144	241
145	242
146	243
148	244
149	245
150	246
151	247
152	248
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311	411
-	412
312	413
-	414
313	415
-	416
-	417
315	418

8.2 Translation of paragraph numbers between TS-R-1 and Safety Series No. 6

SS6	TS-R-1
-	419
-	419
401	501
402	502
403	503
404	504
405	505
406	506
407	507
408	508
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410	510
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433	531
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435	533
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SS6	TS-R-1
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477	580
483	581
484	582
501	601
502	602
503	603
504	604
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505	606
506	607
507	608

8.2 Translation of paragraph numbers between TS-R-1 and Safety Series No. 6

SS6	TS-R-1
508	609
509	610
510	611
511	612
512	613
513	614
-	615
-	615
514	616
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517	619
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540	649
541	650
543	651
544	652
545	653

SS6	TS-R-1
546	654
547	655
542	656
548	656
550	657
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552	659
553	660
554	661
555	662
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556	664
557	665
558	666
-	667
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-	669
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562	671
559	671
560	672
568	673
568	674
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-	676
-	677
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-	679
-	680
-	681
-	682
601	701
602	702
603	703
604	704
605	704
606	704
607	705
608	706
609	707
610	708
611	709
612	710
613	711
-	712
614	713

8.2 Translation of paragraph numbers between TS-R-1 and Safety Series No. 6

SS6	TS-R-1
615	714
616	715
617	716
618	717
-	718
619	719
620	720
621	721
622	722
623	723
624	724
625	725
626	726
627	727
628	728
629	729
630	730
631	731
632	732
633	733
-	734
-	735
-	736
-	737
-	801
701	802
702	803
703	804
-	805
704	806
705	807
706	808
707	809
708	810
709	811
710	812
711	813
712	814
-	815
713	816
714	817
-	818
715	819
716	820
717	821
718	822

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721	825
722	826
723	827
724	828
725	829
726	830
727	831
728	832
729	833
730	834

Attachment 2
TCM Report



**INTERNATIONAL ATOMIC ENERGY AGENCY
DIVISION OF RADIATION AND WASTE SAFETY**

**6th Meeting of
The Transport Safety Standards Committee
(TRANSSC VI)**

**IAEA Headquarters, Vienna
5-9 February 2000**

**DRAFT TECDOC DEVELOPED BY
TC-1156.2 ON TRANSITIONING
ARRANGEMENTS BETWEEN THE 1985
(AS AMENDED 1990) AND 1996 EDITIONS
OF THE TRANSPORT REGULATIONS**

TC-1156.2
Working Paper No. 9
Rev. 1



**INTERNATIONAL ATOMIC ENERGY AGENCY
DIVISION OF RADIATION AND WASTE SAFETY**

**Technical Committee Meeting
to Produce Draft Topical Documents on Provisions for the
Application of the Regulations for the Safe Transport of
Radioactive Material**

**IAEA Headquarters, Vienna
6-10 November 2000**

**DRAFT TECDOC ON TRANSITIONING
ARRANGEMENTS BETWEEN THE 1985 (AS
AMENDED 1990) AND 1996 EDITIONS OF
THE TRANSPORT REGULATIONS**

IAEA-TECDOC-xxxx

Draft 2 dated 9 November, 2000

***Transitioning Arrangements
between the 1985 (As
Amended 1990) and 1996
Editions of the Transport
Regulations***

The originating Section of this publication in the IAEA was:

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FOREWORD

In December 1996 the International Atomic Energy Agency published the 1996 Edition of the *Regulations for the Safe Transport of Radioactive Material* (formerly Safety Series No. 6) in a document called ST-1. That document has served as the basis for revising the UN Committee of Experts Recommendations on the transport of dangerous goods (published in 1999 as “Model Regulations”), and as the basis for the class 7 portions of the forthcoming revisions of RID, ADR, IMO (IMDG Code), ICAO (Technical Instructions) and IATA modal dangerous goods regulations.

ST-1 was subsequently reviewed and revised with minor editorial corrections, and in 2000, a revised English version of the regulations called TS-R-1 (ST-1, Revised) was published.

Difficulties may arise when applying the Regulations during the transition between the 1985 Edition and the 1996 Edition of the Transport Regulations. These difficulties come mainly from the differences between the two regulations, e.g. the definition of radioactive material with the new nuclide-specific exemption levels, the new values of A_1/A_2 , the annual dose limits, the related documentation, the labelling requirements for fissile material package, the changes in UN numbers and proper shipping names, the shipment of fissile material by air, etc.

This TECDOC is intended to provide guidance on the implementation of changes in the *Regulations for the Safe Transport of Radioactive Material*. This guidance may be used to facilitate compliance with the Regulations.

This guidance is aimed at all users of the regulations including National Competent Authorities, consignors, consignees and carriers.

EDITORIAL NOTE

In preparing this publication for press, staff of the IAEA have made up the pages from the original manuscript(s). The views expressed do not necessarily reflect those of the IAEA, the governments of the nominating Member States or the nominating organizations.

Throughout the text names of Member States are retained as they were when the text was compiled.

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1. SCOPE

The purpose of this document is to provide guidance to National Competent Authorities to facilitate compliance during, and after, transitioning from the previous edition of the International Atomic Energy Agency's (IAEA's) transport regulations (Safety Series No. 6, 1985 Edition, As Amended 1990) to the 1996 editions (TS-R-1 [ST-1, Revised], in English [1]; ST-1 in French, Russian, and Spanish) of the regulations. This may also provide guidance to other users of the IAEA's transport regulations such as consignors, carriers, consignees, owners and designers and fabricators of radioactive material and package designers and fabricators.

Recommendations are made as to how compliance with regulatory requirements may be accomplished during and after the transition period. In addition, some of the important changes between the two sets of regulations are highlighted for information.

The reader is advised that there are also changes in the advisory and explanatory material presented in TS-G-1.1 compared with that in Safety Series Nos. 7 and 37. Such changes are not within the scope of this guidance document, which focuses on guidance for compliance with the regulations during transition.

Nothing in this guidance shall be construed as providing relief from national or international requirements or regulations, or the requirements of TS-R-1 and Safety Series No. 6 [2].

2. BACKGROUND

The International Atomic Energy Agency's *Regulations for the Safe Transport of Radioactive Material* are periodically updated to take account of the latest safety information, practices and technologies related to packaging and transport of radioactive material. The updated regulations are then incorporated into requirements of individual member States and international modal organization agreements, conventions, and requirements.

In 1996 IAEA published an updated edition of its transport regulations, ST-1, to supersede Safety Series No. 6, the 1985 (as amended 1990) regulations (SS6). In addition, the shipment schedules, which previously appeared in a separate transport document, Safety Series No. 80, were incorporated into ST-1. In 2000, ST-1 was reissued in English to incorporate errata and to redesignate ST-1 as TS-R-1 (ST-1, Revised), in accordance with IAEA document designation practices.

Originally, a world-wide adoption date of January 1, 2001 was recommended for incorporation of TS-R-1 into modal and State requirements. Despite efforts at an international level to support a uniform implementation date, this date soon proved not to be practical. Certain modal regulatory bodies have stated their intentions with respect to the timing of incorporating TS-R-1, as shown in Table 1. Individual Member State intentions remain less defined, and the timing and extent of incorporation of TS-R-1 may be governed by national legislative procedures. This guidance is being issued in recognition of the importance of a harmonized transition, to facilitate maintaining safety and avoiding unnecessary interruptions to commerce.

	ADR/RID Regulations	ICAO/Technical Instructions	IMO/IMDG code
TS-R-1 starting	01 July 2001	01 July 2001	01 January 2001
SS6 ending	31 December 2001	30 June 2001	31 December 2001
Transition period	6 months	0	12 months

The initial dates for permitting use of TS-R-1 have been synchronized to July 1, 2001 for the cases of the ADR (European Agreement concerning the international shipment of dangerous goods by road), RID (Regulation concerning the international shipment of dangerous goods by rail), and the International Civil Aviation Organization (air mode). For land transport and sea transport (International Maritime Dangerous Goods Code of the International Maritime Organisation), the beginning dates for use of TS-R-1 and the ending dates for use of SS6, are staggered, meaning that during the intervening, "transition period," either TS-R-1 or SS6 may be applied. In the case of the air mode, ICAO will not have a transition period which means that air shipments will be *required* to meet TS-R-1 at all times starting July 1, 2001.

Different schedules and processes exist for each Member States' incorporation of TS-R-1 into national requirements and regulations. Because of this, and the modal organization schedules discussed above, transboundary shipment of radioactive materials in the near future is likely to be complicated by the need to comply with national regulatory requirements which are based upon different versions of the IAEA Transport Regulations (i.e., SS6 and TS-R-1). For example, a problem could occur if one attempts to transport, by land or air with no sea component, a package that complies with TS-R-1 requirements for shipment by sea.

This document presents specific recommendations to National Competent Authorities (CAs). These recommendations are designed to lessen the burden of the regulatory transition and continue to facilitate safe transport practices. In addition, notable differences between SS6 and TS-R-1 are highlighted for the CAs and for the users of the regulations. This should aid in a smooth transition to the new requirements. Principles used in developing this guidance included: (1) maintaining safety, (2) facilitating an efficient and smooth transition; (3) increasing awareness of important changes and their impacts, and (4) attempting to provide pragmatic guidance useful to a broad audience.

While this guidance attempts to remain practicable in its recommendations, it is recognized that certain recommendations, while they may be the most pragmatic solution to the issues, would require the revisions to national and international legal requirements. There is considerable uncertainty regarding the ability to accomplish the necessary agreements before July 2001. It is also not apparent that all necessary state authorities would be willing to become a party to such agreements. This is especially true in many IAEA Member States which have not yet focused on the regulatory transition, or do not yet have language translations of the necessary documents (TS-R-1, TS-G-1.1, or the modal agreements and regulations).

3. REGULATORY TIMEFRAMES OF INTEREST

There are two periods of particular interest when incorporating the new regulations in TS-R-1: the transition period and the post-transition period. Each is further discussed in separate sections below. In addition, Section 3.3 clarifies the timeframes and conditions during which package designs based upon previous editions of SS6 can continue to be manufactured and used, in relation to the regulatory transition to TS-R-1. These provisions are found in TS-R-1 paras. 815-818.

3.1. Transition Period

For this guidance document, the term *transition period* means a fixed time period established by National Competent Authorities (CAs) or modal authorities, during which the continued use of SS6 is allowed.

During a particular CA's transition period, modal organization(s) or other nation(s) through which a given shipment will travel may or may not permit (or require) use of TS-R-1. The responsibility for compliance with all of the applicable regulations is that of the consignor and carrier. If each country or modal organization through which a given shipment will travel still permits transport using SS6-based regulations (even if some of the countries or modal organizations might be in a transition period that permits requirements based on TS-R-1), the most practical solution is to employ SS6 for the shipment. In other cases, to increase familiarity with the new rules, CAs should encourage use of the new regulations during the transition period.

For a given shipment, use of a single set of regulations during the transition period is strongly encouraged, and the set chosen should apply to the shipment from its origin through its destination. This means that a shipment made pursuant to TS-R-1 during the transition period, should comply with TS-R-1 only, and not comply with SS6 (complete, concurrent compliance with both TS-R-1 and SS6 is not possible). For example, complying with sections of TS-R-1 for certain requirements and sections of SS6 for other requirements (e.g., picking the most restrictive A_1/A_2 value for each nuclide) is a practice that should be strongly discouraged. Such practice is practically and administratively confusing and burdensome, has a high potential for actual or perceived non-compliance, and represents a possible challenge to shipment safety. As a second point, a shipment made during the transition period utilizing TS-R-1, as a matter of compliance, needs to comply with TS-R-1 *in total*. This means that the new requirements of TS-R-1, such as radiation protection programmes, need to be in place to enable a shipment to be in compliance with TS-R-1. The practical impact of this is that, for consignor and carrier to use TS-R-1 during the transition, he or she will have had to review their programmes for compliance possibly even before the transition period begins. This is particularly important for air shipments, because ICAO does not have a transition period for the change to TS-R-1.

3.2. Post-Transition Period

After a state's transition to TS-R-1, compliance with the transport regulations can be attained through TS-R-1 only. After a state has transitioned to TS-R-1, an applicable modal organization(s) or another state(s) through which the shipment will travel, may or may not permit (or require) use of TS-R-1. The responsibility for compliance with all of the applicable regulations is that of the consignor and carrier. The national regulations of some nations to/through which a given shipment will travel could still be based upon SS6. In practice, it is envisioned that by that time, modal organizations will already require use of TS-R-1 through their respective, compatible modal requirements. The primary recommendation of this guidance is that CAs of such nations, utilizing their internal processes, permit the use of TS-R-1, at least for import and export shipments (see section 4.1). A similar mechanism that would facilitate continued transport could be development of multilateral agreements to allow use of TS-R-1 for certain shipments. The importance of this recommendation is underscored because, in the absence of such arrangements, safety issues and disruptions of commerce could manifest.

It is recommended that a state, after its transition period, disallow use of SS6 by its consignors and shippers, for export to (or import from) states which still have SS6 based regulations. This recommendation is based upon a presumption that shipments to the SS6-based state will most likely be accomplished pursuant to the modal organization requirements, which will be harmonized with TS-R-1 (or have acceptable state variances) in place at that time. (Note that the state variances to the modal requirements *could* involve 'SS6-like' provisions, but shipments would be accomplished pursuant to the modal requirements in that case and not using SS6 *per se*). Special exceptions/exemptions to the need to comply with TS-R-1 (such as Special Arrangements), or the modal requirements, after transition occurs, should not be routine practice; they should be undertaken only in extraordinary circumstances and should provide for a demonstrated equivalent level of safety.

3.3. Timeline for "Grandfathering" of previously-approved packages under TS-R-1

TS-R-1 allows for further use of approved packages under the transitional arrangements. Such transitional arrangements were incorporated also in former revisions of SS6 and in this way a set of conditions have been formulated for transitional arrangements depending on the revision of SS6 on which basis a package has been licensed. The range of transitional arrangements goes from

- Packages approved under 1967 Edition of SS6, which are no longer to be used;
- Packages approved under 1985 and 1985(As Amended 90) Edition of SS6, which are allowed to be used indefinitely.

Transitional arrangements are fixed for

- the use of packages
- the manufacturing of packages

- unilateral approval
- quality assurance
- application of activity limits and restrictions
- consequences of changing the design
- package specification marking

The timeline for TS-R-1 based transports is illustrated in Table 2 and the transition possibilities in Table 3. The Regulatory Regimes in Table 3 refer to the effective regulations. For example, the first entry in the table has packages going from regime SS6 to SS6.

Transports under the SS6 requirements are possible through the period of transition when both regulations are optionally applicable. For such transports under the SS6 requirements the transitional arrangements of SS6 are still applicable.

TABLE 2 Informational representation of TS-R-1 grandfathering provisions

TS-R-1 transport	31/12/2003	31/12/2006
SS6 package approval basis		
1967	no use	
1973 and 1973(79)	no manufacturing multilateral approval serial-number <i>QA</i> <i>activity limits and restrictions</i> <i>significant changes</i> <i>fissile air transport</i>	
1985 and 1985(90)-packages requiring CA approval	<i>QA</i> <i>activity limits and restrictions</i> <i>significant changes</i> <i>fissile air transport</i>	multilateral approval <i>QA</i> <i>activity limits and restrictions</i> <i>significant changes</i> <i>fissile air transport</i>
1985 and 1985(90)-packages not requiring CA approval	<i>QA</i> <i>activity limits and restrictions</i> <i>significant changes</i>	no use*
Special Form RAM approved under	<i>QA</i>	no new manufacture*

1973, 1973 (79), 1985 and 1985 (90)		<i>QA</i>
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Grey: conditions for further use; italic text: ruled by TS-R-1

* unless qualified to fulfil all TS-R-1 requirements

TABLE 3 Transitional timing

REGULATORY REGIME	NOW	TRANSITION		POST TRANSITION*
		Until 30 June 2001	From 01 July 2001	
SS6 to SS6	✓	✓	✓ ✗ air	✗
TS-R-1 to SS6	✗	✓	✓ ✗ air	✗
SS6 to TS-R-1	✗	✓	✓ ✗ air	✗
TS-R-1 to TS-R-1	✗	✓	✓	✓

*depends on Member States

✓ possible

✗ impossible

grey: state should provide transitional arrangements commencing before mandatory air mode regulations change; shipment under special arrangement, or multilateral agreements to use TS-R-1 incorporated into SS6 state requirements.

4. RECOMMENDATIONS¹

This section presents guidance in the form of recommendations to National Competent Authorities (CAs). The guidance focuses on actions that should become necessary as a result of the worldwide transition to TS-R-1 at different times.

The principles used in making the recommendations are

- (1) that safety is not compromised as a result of transitioning regulations;
- (2) that a given shipment is made all the way from consignor to consignee under (i.e., in compliance with) a single set of regulations (based on SS6 or based on TS-R-1), regardless of whether the shipment is domestic, international or multi-modal;
- (3) that any guidance, if followed, does not lead to non-compliance with the regulations in any state or mode with authority over the shipment; and
- (4) that guidance express preference for the most practical solution, provided an equivalent level of safety is retained.

4.1. Primary Recommendations

4.1.1. Permissive use of TS-R-1

- **CAs should act to permit use of TS-R-1, at least for certain shipments, by 01 July 2001.**
- **CAs should assess its TS-R-1 adoption date (and transition period, if one is planned) against the dates to be employed in the modal regulations (see Table 1) that concern shipment to, from, and within that CA's nation.**
- **Where CAs determine that TS-R-1 will not be incorporated by the date to be used by an applicable modal organization, CAs are strongly encouraged to provide an alternative solution such as the use of regulatory substitutions or multilateral agreements.**
- For example, a multi-lateral agreement, pursuant to certain modal regulations, could be used to allow derogation of certain requirements that would otherwise apply to a shipment. This assumes that the national requirements already permit the use of the applicable modal organization requirements (and the permission would remain in place after those modal requirements become TS-R-1-based). However, practical problems need to be acknowledged regarding obtaining approval (potentially by many states and in many languages) of the agreement through the modal organization. The following text, provided for information, is an example of a draft multi-lateral agreement.

1. Packages of Class 7 material, including intermediate bulk containers (IBC), freight

¹ The recommendations shown in this section are highlighted in bold text.

containers and tanks, which do not entirely comply with the prescriptions relating to materials, packaging, or hazard communications (marking, labelling, placarding, and shipping papers) of the [SS-6 based national requirements], but which otherwise comply with the parallel prescriptions in [the relevant modal requirements, or TS-R-1], may be shipped to [nation(s) which has (have) incorporated TS-R-1 into their national requirements].

2. [Additional conditions and restrictions of approval, as appropriate.]
3. This multilateral agreement is applicable from 01 July 2001 through [date of TS-R-1 incorporation in SS-6-based nation(s)] and [other conditions as appropriate].

- **CAs should permit the use of TS-R-1 itself or TS-R-1 based modal requirements, for import, export and transboundary movement of Class 7 materials.** This can be achieved, for example, through a change to its national regulatory infrastructure or exemption process. This guidance presumes that such changes might be accomplished in a more timely manner than complete harmonization of domestic requirements with TS-R-1. Note that in this case, TS-R-1 requirements as embodied in the modal regulatory provisions, could substitute for the existing (e.g., SS6-based) national requirements only for shipments where such substitution is necessary (those where modal requirements based on TS-R-1 would apply) and possibly only until such time as the domestic regulations are harmonized with TS-R-1. Examples of this approach can be found in the domestic regulations of the United States, U.S. Code of Federal Regulations Title 49 Part 171, Section 11 (permits use of ICAO Technical Instructions) and Section 12 (permits IMDG code and IAEA regulations).

4.1.2. Communication and Training

- **To the extent practicable, CAs are strongly recommended to take proactive steps to inform its users (including consignors, carriers, consignees, package designers, fabricators, emergency responders) of the pending changes in regulations, paying particular attention to the safety issues highlighted in section 4.2 of this document.** Generic letters to licensees and certificate holders could be one means of accomplishing this communication. The information in section 5 of this document could provide the basis. However, it is recognized that communication to all interested parties is difficult in many countries.
- **It is recommended that emergency response guides for first responders be updated or supplemented to incorporate current UN identification numbers and proper shipping names.** These guides will reduce the potential for misunderstanding after an accident involving packages transported under the new requirements.
- **It is recommended that if shipments are expected that utilize regulations based on TS-R-1, training be given to transport workers and emergency responders prior to the introduction of TS-R-1 based regulations.** Failure to do so introduces a potential for improper package handling or emergency response during transport, due to a misunderstanding of the changed package handling requirements and marking, labelling, placarding, and shipping paper requirements.

See section 4.2. The IAEA has training material associated with the changes in the regulations that could be freely distributed to aid in this effort.

- The recommendation that CAs facilitate communication and training on the upcoming regulatory changes is particularly important when considered in conjunction with the recommendation above for early permission to use of TS-R-1 on imports, exports, and transboundary shipments in countries whose domestic harmonization with TS-R-1 will be delayed. For example, if a nation with SS6-based regulations were to permit use of TS-R-1 packages on an air import, the transport workers or emergency responders that encounter the package might not be familiar with the hazard communications (e.g., the marked UN identification number) they encounter.
- **CAs should also attempt to identify methods to notify previously non-regulated bodies, which may become subject to the regulations based on TS-R-1, as a result of the changes to the exempt concentrations and consignment limits and the changes in scope (see section 5.1 and 5.13.5).**

4.1.3. Compliance Assurance

- **CAs should further focus their compliance assurance efforts on safety issues, immediately after transitioning to TS-R-1.**
- Successfully implementing and complying with the changes implemented in TS-R-1 is likely to involve a learning process by both the regulators and the users of the regulations.
- **Immediately after the transition to TS-R-1, it is recommended that CAs take steps in applying compliance assurance measures to be particularly mindful of the possible implications to transport safety of practices that are adopted (including but not limited to violations of the requirements).** Emergent issues of potential safety significance could arise that involve continuation of past practices, differing interpretations of the new regulations, or violations of the requirements.
- **It is recommended that safety issues that are identified be promptly communicated to IAEA to support additional dissemination of that information.**
- **In addition, it is recommended that CAs tailor their enforcement strategy to acknowledge the regulatory familiarization period.** This approach would recognize that many issues with complying with TS-R-1 as compared to SS6 are of very little or no safety significance.
- **Users should be assisted (to the extent appropriate) and encouraged to promptly institute corrective actions of violations or weaknesses.**

4.2. Potential Safety Issues

This section discusses the potential safety issues, that have been identified, associated with the transition to TS-R-1. In this guidance, the term *safety issue* means an issue that represents a possible event occurring and resulting in a fair hazard to the transport worker or public safety and health. Most non-compliance events that can be envisioned as a direct consequence of the SS6 to TS-R-1 transition would not be safety issues, but rather compliance (e.g., administrative) issues; for example, failure to comply with the TS-R-1 radionuclide specific exemption values as compared to the SS6 value of 70 Bq/g, appears to have little relevance to safety significance due to the potential radiological exposure that might occur. The identified safety issues is as follows:

4.2.1 Potential for improper package accumulation (separation of CSI from the TI)

- If a package containing fissile materials, that is transported based on TS-R-1 requirements, arrives at a location that is using SS6-based regulations, a transport worker might not understand the CSI and fissile label (which are newly introduced). Because package accumulation in transit (based on nuclear criticality considerations), is controlled by either: (1) limits on the total TI under SS6, or (2) limits on the total CSI under TS-R-1; the worker could inadvertently place packages together in violation of TS-R-1 para. 569. This could represent a potential nuclear criticality hazard. It is noted that a SS6 based country issued as the likely example, but is not a prerequisite. The above situation could occur even in a country that *has* transitioned to TS-R-1, if the issue is not adequately communicated, and training provided, down to the transport worker level.
- To further illustrate the above, the following example is given: Package X is an SS6 package with a TI of 10; based on a value of 1 for radiation safety and 10 for criticality safety). It is labelled and marked on the label with a TI=10. Package Y is identical but based on TS-R-1. It has a TI of 1 and CSI of 10. It has two labels, the traditional label showing a TI of 1 and the newly introduced fissile label showing a CSI of 10. In order to assure safety, both SS6 and TS-R-1 would require no more than 5 of these packages be grouped (total TI of 50 under SS6, or total CSI of 50 under TS-R-1). However, a transport worker experienced only with SS6 might well group 50 of Package Y together.
- In a converse situation, if a fissile package, that is based on SS6 requirements, arrives in a location that is using regulations based on TS-R-1, a transport worker might mistakenly believe that the TI on that package is not related to criticality control (that package would not have a CSI or fissile label if shipped per SS6). As a result, the worker could inadvertently store or load that package together with other fissile packages - be they based on SS6 or TS-R-1 - representing a potential nuclear criticality hazard.
- There does not appear to be a shipping practice that could entirely eliminate the potential for these occurrences. However, an example of how to deal with this situation is as follows:

During the transitional period of applying SS6 and ST-1 in parallel the accumulation of packages containing fissile material could be controlled as follows:

- a) If the accumulation is subject to the SS6 regime that means based on the TI according to SS6 then for those packages which are declared according to ST-1 that means labelled with the TI and CSI according to ST-1 the higher number of both the CSI and TI must be used for control as TI according to SS6,
- b) If the accumulation is subject to the ST-1 regime that means based on the TI and CSI according to ST-1 then for those packages which are declared according to SS6 that means labelled with the TI according to SS6 this TI must be used for control as CSI and also as TI according to ST-1.

The labelling of SS6 shipments with the fissile label and showing a CSI may be non-compliant with SS6 based rules under which the shipment was made under, violates a principle of this guidance to use one set of regulations entirely, and also does not appear to sufficiently resolve either of the above situations.

- **It is recommended that CAs should advise consignors of fissile material to notify the carriers (e.g., using special instructions) of their fissile consignments of this problem; (2) CAs should encourage communication of this issue and training appropriate to the level of the transport workers. Specifically, handlers should be trained to concurrently use the criticality aspects of the TI based upon SS6, and the radiation safety aspects of the TI and criticality safety aspects of the CSI in TS-R-1.** As the community of users of fissile radioactive material is generally well known and regulated to a greater extent, this communication should be feasible.

4.2.2 Potential for inadequate emergency response due to unfamiliar hazard communications (UN Number and Proper Shipping Names)

- If a package, that is transported based on TS-R-1 requirements, arrives in a location that is using SS6-based regulations, a transport worker or emergency responder after an accident might not recognize the UN Identification Number and Proper Shipping Name. A table showing the correspondence between the old and new UN numbers and proper shipping names is given in Section 6.3. This has the potential of resulting in inadequate emergency response actions, as the UN ID Number is sometimes used by the first responder, in conjunction with emergency response guidance, to identify the appropriate immediate protective and mitigative actions. However, it is noted that the proper shipping name is required to be marked on TS-R-1 package and will include the terms, "RADIOACTIVE MATERIAL,..." and "...FISSILE..." as appropriate. This fact should help reduce the potential significance of this issue, as at least the hazard class of the material would be apparent and could be correlated to previous emergency response guidance.
- **It is recommended that CAs update the applicable emergency response guidance, and also to follow the communications recommendations of section 4.1.2.**

4.3 Potential Compliance Issues

This section identifies issues and makes recommendations to CAs for issues relating to possible non-compliance, caused by regulatory transition, that are not considered in themselves to be safety issues.

4.3.1 New Flux / Dose Equivalent Rate Conversion Factors

- **It is recommended that transports under TS-R-1 during the transition period comply with the dose rate limits measured according to the new dose quantities irrespective to the transitional arrangements concerning package approval.** Using new dose quantities is also mandatory for TS-R-1 regulated transports in the post transition period. With respect to the allowed contents of a package based on a former approval on the basis of the old dose quantities, there is no immediate need for a renewed assessment of the dose rate calculations and subsequently no immediate need for a revision of the certificate of package approval. The necessary dose rate measurements before any shipment, which are based on the new quantities, should ensure that no violation of the dose rate limits will occur.
- **It is recommended that consignors should assess before loading of packages whether the transfer to the new dose quantities has the potential of reaching dose rate levels in excess of the limits.** The overall practice of loading shows that packages normally are not loaded up to the maximum contents permitted by the package approval certificate. However, there might be situations in which this will be the case and for those situations, unloading a loaded package after the measurement has demonstrated a too high dose rate level should be avoided for radiation protection reasons.
- It should be noted that any dose rate measurement made in accordance with the older flux-to-dose conversion factors, revealing a dose rate level of less than 2/3 of the limit, has, *per se*, no capability of leading to excessive dose rates. The factor for the transfer from the old dose quantities to the new ambient dose equivalent is, for all practical purposes, no more than about 1.5.
- **It is recommended that CAs be prepared to assess applications for design approval to the TS-R-1 requirements before these requirements enter into force. Additionally, new package approvals to be issued in the time period when both SS6 and TS-R-1 are optionally valid should be issued on the basis of TS-R-1 requirements.** This means that with respect to dose rate calculations that the new dose quantities have to be applied in the safety assessment analysis.

4.3.2 Development and Introduction of Radiation Protection Programme

- Earlier versions of the transport regulations differ from TS-R-1 in that the latter explicitly requires that a radiation protection programme be established. The elements of a radiation protection

programme may differ substantially, according to the nature and number of transports, and their radiological significance. Special advice on the contents and the recommended elements of a radiation protection programme will be given in a forthcoming IAEA TECDOC on Radiation Protection Programmes.

4.3.3 Changes in A Values

- “A” values have changed for certain radionuclides. The changes for many radionuclides are rather limited, with most values within a factor of three of the earlier ones. There are few A_1 or A_2 values lower than the previous figures by more than a factor of 10 (See Section 6, Table 6.4). Most of the “A” values for important, often transported radionuclides remain essentially unchanged (see Table 6.4). Package safety analysis reports or design justifications for Type B packages need not be automatically revised where it has been shown generically that there to be no safety problem, as in most cases there is a large margin of safety. This is true for packages, which will be used under the transitional arrangements of TS-R-1. For example, it is the experience of the U.S. in the certification of Type B packages that the containment analyses performed in accordance with ANSI N14.5 embody assumptions that provide a sufficient margin of safety that changes in A_2 values do not affect the ability of the package to meet the regulatory release limits.
- **New package design justifications and approvals should explicitly consider the revised “A” values, even during the transition period.**
- The change of “A” values has to be taken into account when considering package and material activity limits and restrictions. There may, in some cases, where the change of A values leads to a change in packaging requirements. For example, excepted quantities of radioactive material under SS6 may become type A quantities under TS-R-1 and Type A quantities of radioactive material under SS6 may become Type B quantities under TS-R-1. This is a known issue, where certain radiopharmaceuticals despatched in single patient doses in excepted packages under SS6 will require type A packages under TS-R-1 for the same level of activity.

4.3.4 Packages containing Uranium Hexafluoride

- There are new requirements in TS-R-1 for packages containing uranium hexafluoride, which are of particular concern where non-fissile or fissile excepted UF_6 is to be transported. Section 5.13.4 summarises the new requirements, which also apply to all approved package designs for fissile UF_6 . It should be noted that previously approved fissile UF_6 package designs may already meet these new requirements if they also satisfy the provisions of ISO 7195.

4.3.5 Fissile Material shipments by air

- For shipment of fissile material by air, TS-R-1 requires that packages with quantities greater than excepted amounts require an additional criticality evaluation during certification (see section 5.13.3). Packages must remain subcritical, assuming 20 centimetres water reflection but not in-leakage (i.e.,

moderation) when subjected to the tests for Type C packages (See Section 4.3.9). The specification of no water ingress protection from criticality events resulting from rapid mechanical or physical rearrangement of the geometry of the package. Note that the application of the paragraph 680 requirement to fissile-by-air packages is in addition to the normal condition tests and accident tests that the given package already must meet.

- Certain factors need to be considered in determining the practical impacts of domestic adoption of TS-R-1 paragraph 680. First, all uranium can be shipped in non-Type C package (IF, AF) due to its A_1 and A_2 values. The paragraph 680(a) requirements appear to be readily satisfied by low-enriched uranium, because low enriched uranium (less than approximately 5% enrichment) would typically require moderation (e.g., by water) to achieve nuclear criticality, but the test specifies no water ingress. This lends itself to a potential generic solution (possibly by CAs or an industry group) for air transport of low enriched uranium packages that do not contain moderating material as part of the contents or packaging.
- **It is recommended that CAs consider the need to revise each certificate packages containing for fissile material to include a condition showing an expiration date for air transport of 30 June 2001.** This date is the ICAO adoption date, and notes that because there is no ICAO transition period (see Table 1), this issue needs to be resolved to satisfaction prior to 30 June 2001.

4.3.6 Hazard Communications

- Marking, labelling, placarding and transport documentation have changed. Of particular note is the introduction of 25 new or revised UN numbers, which must be marked on the outside of every package and on the transport documents. An overview of the details of the changes is presented in sections 5.8 and 5.9 of this TECDOC. The comparison is given in Section 6, Table 6.3.

4.3.7 Quality Assurance Requirements for Grandfathered Packages and Special Form Radioactive Materials

- For packages approved by CAs under the 1973 or 1973 (As Amended) editions of Safety Series No. 6, TS-R-1 paragraph 816 states that such packages may continue to be used subject to "...the mandatory programme of quality assurance in accordance with the *applicable* requirements of para. 310;...".
- For special form radioactive material manufactured to a design approved by CAs under the 1973, 1973 (As Amended 1979), 1985 or 1985 (As Amended 1990) editions of Safety Series No. 6, TS-R-1 paragraph 818 states that such material may continue to be used when in compliance with "the mandatory programme of quality assurance in accordance with the *applicable* requirements of para. 310."
- These requirements emphasize the need to apply quality assurance measures according to the 1996 Edition of the Regulations to ensure that packages and special form materials remains in use, only

where they continue to meet the original design intent or regulatory requirements. This can best be achieved by ensuring that the latest quality assurance measures are applied to post-manufacturing activities such as servicing, maintenance, modification and use of such packages and special form material.

4.3.8 Exempt shipments

- The definition of the exemption values in TS-R-1 have changed from the 70 Bq/g limit applied to all radionuclides in SS6, to a combination of radionuclide specific activity concentration together with a radionuclide specific activity limit per consignment. For the material to be considered radioactive under TS-R-1, both the specific activity limit and the consignment limit must be in excess of the values given.
- There are situations where the TS-R-1 exemption values are above the 70 Bq/g criterion of SS6 for certain radionuclides, and below the SS6 criterion for others. The new exemption values of TS-R-1 are based on detailed dose assessments, based upon a dose uptake to critical groups of occupational workers of 10 μ Sv in a year. Hence the limits imposed ensure that there is no radiological hazard either to people involved in the transport or to people that may otherwise be exposed.
- The advantage of the new exemption values is that they are harmonized with those recommended by the Basic Safety Standard [3] for radiation protection purposes. It is recommended that CAs accept the use of the new exemption values irrespective of the fact that for a transition period, the new exemption values may be for certain shipments higher than the SS6 based regulation would allow.

4.3.9 Material restrictions on air shipments

- TS-R-1 introduces activity limits for shipment by air.
- The maximum activity that is allowed in a single industrial package containing non-combustible solid LSA-II or LSA-III material for shipment by air is 3000 A_2 .
- The maximum activity allowed in a single type B package for shipment by air is 3000 A_1 (but not greater than $10^5 A_2$) for material as special form, and 3000 A_2 for material not as special form, unless the package contains CA-approved low dispersible material (LDM) in approved quantities.

It is recommended that CAs consider revising all certificates of approval where the air mode quantity restrictions apply in the following manner:

1. **Show an expiration date of 30 June 2001 for air mode use or**
2. **Reduce the authorized contents so the air mode restrictions do not apply or**
3. **Exclude air mode from the CA approval.**

- LDM must be of a limited radiological hazard and meet a range of specified impact, thermal and leaching tests. Multilateral CA approval of the LDM is required (with a new approval certificate type code “LD”), and type B(U) package designs for the carriage of LDM also require multilateral CA Approval.
- Material with an activity above the limits presented above must be transported in a new Type C package. Type C packages must withstand an enhanced series of regulatory tests and require CA approval, except where the contents are fissile, in which case multilateral shipment approval is required. The contents and activity limits of type C package are authorised by CAs.

5. NOTABLE CHANGES

This section presents information on the notable differences between Safety Series No. 6 and TS-R-1, and is intended to be of equal value to both National Competent Authorities (CAs) and other users of the Regulations.

The following points are categorized similarly to the schedules of requirements included in TS-R-1. This list is probably not exhaustive, but represents the most important changes. As such the user should satisfy themselves that all changes relevant to their particular situation have been identified and addressed. Paragraph numbers at the end of each change identify their location in TS-R-1.

N.B. TS-R-1 requires the use of SI units throughout.

5.1 Materials

- ◆ *Radioactive material has been redefined - radionuclide dependent material specific activity exemption limits and exempt consignment activity limits are introduced in TS-R-1. As a result of the definition of radioactive material changing, with radionuclide dependent material specific activity exemption limits and exempt consignment activity in TS-R-1, materials which were previously not defined as radioactive under Safety Series No. 6 may be defined as radioactive under TS-R-1, and vice versa. [paras 236]*
- ◆ *TS-R-1 contains revised A_1 and A_2 values (including lung absorption types for Uranium). Not all have changed, but some of the changes are significant [para 401].*
- ◆ *The consequences of revised A values for materials are new LSA values and new release limits for LSA-III. Materials that exceed the exempt activity concentration by more than 10 times, but less than 30 times, by consignment may be transported as LSA-I provided they are not fissile or are fissile excepted. LSA-I material may be transported unpackaged or in bulk, but there must be no escape of material from the conveyance during routine transport [para 226a].*
- ◆ *The LSA-III material definition specifically excludes powders in TS-R-1 [para 226c].*
- ◆ *Low Dispersible Radioactive Material (LDM) is introduced in TS-R-1. LDM must be of a limited radiological hazard and meet a range of specified impact, thermal and leaching tests. Multilateral CA approval is required, with a new approval certificate type code "LD". Type B(U) package designs for the carriage of LDM require multilateral CA Approval [paras 712, 806(b) and 828(c)].*
- ◆ *Special Form radioactive material of less than 200g mass can be excepted from the TS-R-1 bending and percussion tests, providing specimens are alternatively subjected to the Class 4 impact test specified in ISO2919, and from the TS-R-1 heat test providing specimens are alternatively subjected to the Class 6 temperature test specified in ISO2919 [para 709].*
- ◆ *The definition of unirradiated Uranium has been amended in TS-R-1 [para 245].*
- ◆ *Revised transitional arrangements mean that Special Form radioactive material approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) regulations may*

continued to be manufactured and used until 31.12.2003, but with TS-R-1 Quality Assurance (QA) requirements. Special Form radioactive material approved under other than the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) editions of the regulations is no longer allowed under TS-R-1 [para 818].

5.2 Packaging

- ◆ *The consequences of revised A values for packages include new activity limits for excepted packages and new release limits for Type B and Type C packages after testing. [para 408, and 410]*
- ◆ *The alternative requirements for IP-2 and IP-3 packages allowed in TS-R-1 are more stringent - IP-2 must meet UN packing group I or II requirements; freight containers used as IP-2 or IP-3 packages are only allowed to carry solid radioactive material; only metallic Intermediate Bulk Containers (IBCs) are allowed, and IBCs must be tested in the most damaging orientation. [paras 622 and 623]*
- ◆ *Package contents limitations for Industrial & Type B packages by air have been introduced in TS-R-1. Non-combustible solid LSA-II or LSA-III is limited to $\leq 3000 A_2$ per package. Type B packages are limited to carrying material with an activity $\leq 3000 A_1$ or $\leq 10^5 A_2$ as special form, whichever is the lower; $\leq 3000 A_2$ not as special form; or approved LDM. [paras 412 and 416]*
- ◆ *Type C Packages for shipment of quantities of radioactive material prohibited in other packages have been introduced in TS-R-1. CA approval is required, with a new approval certificate type code "C." [paras 417, 806 and 828c]*
- ◆ *Pressure and temperature requirements for all packagings - the design shall take into account ambient temperatures and pressures likely to be encountered in routine conditions of transport and the containment system shall retain the radioactive contents under a reduction in ambient pressure to 60 kPa (unless being transported by air when the containment system shall retain the radioactive contents under a reduction in ambient pressure to 5 kPa). [paras 615, 619 and 643]*
- ◆ *The enhanced water immersion test (200m for one hour) previously reserved for packages containing irradiated nuclear fuel has been extended to all Type B packages containing $>10^5 A_2$, and all Type C packages in TS-R-1. [paras 730]*
- ◆ *Revised transitional arrangements mean that, for packages not requiring CA approval of a design and meet the requirements of 1985 and 1985 (As Amended 1990) regulations, manufacture is allowed until 31.12.2003 but with TS-R-1 package QA, activity limits and material restrictions. Such packages prepared for transport not later than 31.12.2003 may only be consigned once after this date. Any subsequent consignment must meet TS-R-1 requirements in full. [para 815]*

For packages approved by CAs under the 1973 and 1973 (As Amended) regulations, further packaging manufacture is not allowed and use of existing packages is only permissible with multilateral approval, TS-R-1 appropriate QA, activity limits, material restrictions and

criticality restrictions for transport of fissile material by air (if appropriate). [para 816]

For packages approved by CAs under the 1985 and 1985 (As Amended 1990) regulations, manufacture is allowed until 31.12.2006. Packages may be used until 31.12.2003 but with TS-R-1 QA, activity limits, material restrictions and criticality restrictions for transport of fissile material by air (if appropriate). Multilateral approval shall be required from 01.01.2004. [para 817]

Packages approved under other than the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) editions of the regulations are no longer allowed under TS-R-1. [para 817]

5.3 Maximum Radiation Levels

- ◆ *No notable regulatory changes.*

5.4 Contamination

- ◆ *Contamination limits have been harmonized for all package types. [paras 508-514]*

5.5 Decontamination and Use of Conveyances

- ◆ *No notable regulatory changes*

5.6 Mixed Contents

- ◆ *Use of tanks and IBCs for other goods is not permitted unless they have been decontaminated. [para 504]*

5.7 Loading and Segregation

- ◆ *In TS-R-1, the Transport Index is used solely for radiation control. A new index, the criticality safety index (CSI) is used for criticality control. The CSI effectively replaces the TI for criticality control used in Safety Series No. 6. There is no requirement for separation distances in the TS-R-1 Transport Index. These are now presented in the TS-R-1 CSI table. The limit on the sum of Transport Index and the limit on the sum of CSI on a conveyance are not necessarily the same. [paras 530, 566-569 and Tables IX and X]*

5.8 Labelling and Marking

- ◆ *New non CA approved package external marking requirements are presented in TS-R-1. The package must be legibly and durably marked with an identification of the consignor or consignee, or both; Excepted packages must be legibly and durably marked with "UN" and*

the new UN number; All other non CA approved packages must be legibly and durably marked with "UN", new UN number and proper shipping name (PSN); Industrial Packages must be marked with "TYPE IP-1" (or IP-2 or IP-3, as appropriate); Type A packages must be marked with "TYPE A"; IP-2, IP-3 and Type A packages must be marked with the vehicle registration identification (VRI) code and the name of packaging manufacturer, or other identification of the packaging specified by the CA. [paras 534, 535, 537 and Table VIII]

- ◆ *New CA approved external package marking requirements are presented in TS-R-1. The package must be legibly and durably marked with "UN"; the new UN number and proper shipping name; and an identification of the consignor or consignee, or both. Type B and Type C packages must be marked with "TYPE B(U)", "TYPE B(M)", or "TYPE C", as appropriate and a fire / water resistant trefoil symbol. Also the outer surface of receptacles or wrapping materials containing LSA-I or SCO-I material is now allowed to bear the marking "RADIOACTIVE LSA-I" or "RADIOACTIVE SCO-I," AS appropriate. [paras 535, and 538-540]*
- ◆ *TS-R-1 presents 25 new or revised UN numbers, proper shipping names and descriptions. All proper shipping names begin "RADIOACTIVE MATERIAL". Where UN numbers have been retained, the actual scope may be different from Safety Series No. 6. [para 535 and Table VIII]*
- ◆ *For fissile packages, Safety Series No. 6 required that the category label show the higher of the transport index for radiation exposure control and the transport index for nuclear criticality control. TS-R-1 effectively splits this into two separate labels. The Transport Index (formerly the transport index for radiation exposure control) continues to be marked on the category label (II Yellow or III Yellow, as appropriate). Packages containing fissile material must also be labelled with a criticality safety index (CSI) label. The CSI label must show the CSI (formerly the transport index for nuclear criticality control) for the package. [paras 544 and 545]*
- ◆ *TS-R-1 allows the trefoil symbol on category labels to be slightly smaller than under Safety Series No. 6. [paras 540-543 and Figures 2-4]*

5.9 Placarding

- ◆ *TS-R-1 allows smaller placards (minimum side dimension = 100mm) to be used where vehicles have insufficient area to allow the fixing of larger placards, and allows the trefoil symbol on placards to be slightly smaller than under Safety Series No. 6. [paras 546 and 570 and Figure 6]*
- ◆ *TS-R-1 presents 25 new or revised UN numbers, proper shipping names and descriptions. All proper shipping names begin "RADIOACTIVE MATERIAL". Where UN numbers have been retained, the actual scope may be different from Safety Series No. 6. [paras 535 and Table VIII]*

5.10 Transport Documents

- ◆ *TS-R-1 presents 25 new or revised UN numbers, proper shipping names and descriptions. All*

proper shipping names begin "RADIOACTIVE MATERIAL". Where UN numbers have been retained, the actual scope may be different from Safety Series No. 6. [paras 535, 549(a) and 549(c) and Table VIII]

- ◆ *Consignment documents for LSA-II, LSA-III, SCO-I and SCO-II must show the total activity of the consignment as a multiple of A_2 . [para 549(m)]*

5.11 Storage and Dispatch

- ◆ *No notable regulatory changes*

5.12 Carriage

- ◆ *As a result of the definition of radioactive material changing, with radionuclide dependent material specific activity exemption limits and exempt consignment activity in TS-R-1, materials which were previously not defined as radioactive under Safety Series No. 6 may be defined as radioactive under TS-R-1, and vice versa. [para 236 and Table I]*
- ◆ *As a consequence of the revised A values presented in TS-R-1, there are new conveyance limits for LSA / SCO. [para 525 and Table V]*
- ◆ *Packages used for the transport of radioactive material by air must have a containment system capable of retaining the radioactive contents under a reduction in ambient pressure to 5 kPa. This requirement applies to all package types (including excepted), and material phases. [para 619]*
- ◆ *Consignment mass limits are introduced for exceptions from the requirements for packages containing fissile material. [para 672 and Table XII]*
- ◆ *CAs must be notified of shipments of Type C packages containing >3000 A_1 or >3000 A_2 , as appropriate, or 1000 TBq, whichever is the lower. [para 558]*

5.13 Other Provisions

5.13.1 Radiation Protection Programme

- ◆ *Radiation Protection Programmes are explicitly required by TS-R-1 for the transport of radioactive materials. The revised Basic Safety Standard sets a 20 mSv annual exposure limit (averaged over 5 years), with a maximum of 50 mSv in any one year. [para 301]*

5.13.2 Quality Assurance and Compliance Assurance for Special Form and Low Dispersible Radioactive Material

- ◆ *The requirement for Quality Assurance and Compliance Assurance for Special Form and Low Dispersible Radioactive Material (LDM) has been explicitly added in TS-R-1. [para 310]*

5.13.3 Transport of Fissile Material

Fissile Material and Design Requirements have changed in TS-R-1.

- ◆ *Revisions to the exceptions from the requirements for packages containing fissile material allow only one type of exception per consignment, and introduce mass limits per consignment, together with other minor changes. [para 672]*
- ◆ *The definition of LSA-I material explicitly allows for the presence of fissile material in excepted quantities. [para 226]*
- ◆ *Pu₂₃₈ is no longer considered fissile for the purposes of TS-R-1. [para 222]*
- ◆ *Escape of material from damaged containment systems in CA-approved packages is covered explicitly in TS-R-1. [para 682©]*
- ◆ *A new definition, that of the “Confinement system,” is introduced. This is the assembly of fissile material and packaging components specified by the designer and agreed to by the CA as intended to preserve criticality safety. [para 209]*
- ◆ *For air shipments, the “Type B” assessment conditions relating to a single package must not take into account water barriers unless the water barriers have been proven to withstand the Type C test requirements without leakage. [para 680(b)]*
- ◆ *When taking account of irradiation of nuclear fuel (burnup credit) in a criticality safety case, pre shipment (post irradiation) measurement is required to confirm the conservatism of the assumed isotopic composition. [para 674(b)]*
- ◆ *For the transport of fissile material by air, the system must be shown to remain safely subcritical under conditions consistent with the tests for Type C packages but assuming no water in-leakage. [para 680(a)]*
- ◆ *An operating temperature range of -40°C to +38°C is explicitly stated in TS-R-1 for all fissile packages. [para 676]*
- ◆ *The requirement in Safety Series No. 6 for a free drop test from a height of 0.3m on each corner (or onto the quarters of each rim for a cylindrical package) is deleted in TS-R-1. [no para]*
- ◆ *When formulating the criticality safety case, TS-R-1 does not require the examination of the containment system in isolation if the confinement system remains within the package. [para 678]*

5.13.4 Transport of Uranium Hexafluoride

- ◆ *Packages containing >0.1kg UF₆ must not be fitted with pressure relief devices, will require CA approval and must withstand without leakage an internal hydraulic pressure test of 1.38 MPa (those withstanding less than 2.76 MPa require multilateral approval); a 0.3m – 1.2m drop test (depending on the mass of the package) and an 800°C thermal test for 30 minutes (multilateral approval is required for packages >9000kg not withstanding the thermal test). [paras 630-632 and 805]*
- ◆ *Packages must meet the requirements of ISO7195 (or equivalent requirements, as agreed with the CA), together with the TS-R-1 requirements regarding the radioactive and fissile properties of the material to be transported. [paras 629 and 632]*
- ◆ *Where a design requires multilateral approval, certification will be required from 01.01.2002, unless by air. Where a design requires unilateral approval, certification will be required from*

01.01.2004. [para 805]

- ◆ *New CA approval certificate type codes “H(U)” and “H(M)” for non-fissile or fissile excepted UF₆ packages requiring unilateral or multilateral CA design approval respectively. [para 828(c)]*
- ◆ *Where fissile UF₆ is being transported, the fissile requirements of TS-R-1 must be met with no contact between valves and other normally non-contacting parts, and no leakage from the valve. [para 677(b)(i)]*

5.13.5. Scope

- ◆ *The scope of applicability of TS-R-1 no longer includes consumer products after sale to an end user or the transport of live animals after treatment with radioisotopes. [para 107(d)]*
- ◆ *Transport, comprising all operations and conditions associated with and involved in the movement of radioactive material, has been extended to specifically include the repair of packaging. [para 106]*

6. CORRESPONDENCE TABLES BETWEEN SAFETY SERIES NO. 6, 1986 EDITION (AS AMENDED 1990) AND TS-R-1

This Section contains four Tables that translate information between SS6 and TS-R-1. They are intended to facilitate the user's understanding of the changes between these two editions. Table 6.1 provides a map for relating para numbers in SS6 to corresponding paras in TS-R-1. Conversely, Table 6.2 relates para numbers in TS-R-1 to the corresponding paras in SS6. Table 6.3 provides a cross reference between the old and new UN ID numbers and proper shipping names. Finally, Table 6.4 compares the A_1 and A_2 values between SS6 and TS-R-1 and highlights those radionuclide values that have been lowered in TS-R-1.

Table 6.1
Correspondence of
paragraph numbers between
SS6 and TS-R-1

SS6	TS-R-1
-	102
-	104
-	110
-	209
-	218
-	224
-	225
-	227
-	234
-	301
-	302
-	303
-	305
-	412
-	414
-	416
-	417
-	419
-	529
-	534
-	535
-	540
-	544
-	545
-	605
-	615
-	620
-	624
-	628
-	629
-	630
-	631
-	632
-	663
-	667
-	668
-	669
-	670
-	675
-	676
-	677
-	678
-	679
-	680
-	681
-	682
-	712
-	718
-	734
-	735
-	736
SS6	TS-R-1
-	737
-	801

-	805
-	815
-	818
101	101
102	106
103	107
104	108
105	109
107	105
108	103
109	-
110	201
111	202
112	203
113	204
114	205
115	206
116	207
117	208
118	210
119	211
120	212
121	213
122	214
123	216
124	215
125	217
126	219
127	220
128	221
129	222
130	223
131	226
132	228
133	229
134	230
135	231
136	232
137	233
138	235
139	236
140	237
141	238
142	239
143	240
144	241
145	242
146	243
147	-
SS6	TS-R-1
148	244
149	245
150	246
151	247
152	248
201	-
202	-
203	304
204	-
205	306
206	307
207	308
208	309
209	310
210	311
211	312

301	401
302	402
303	403
304	404
305	405
306	406
307	407
308	408
309	409
310	410
311	411
312	413
313	415
314	-
315	418
401	501
402	502
403	503
404	504
405	505
406	506
407	507
408	508
409	509
410	510
411	511
412	512
413	513
414	514
415	515
416	516
417	-
418	517
419	518
420	519
SS6	TS-R-1
421	520
422	521
423	522
424	-
425	523
426	524
427	525
428	526
429	528
430	527
431	-
432	530
433	531
434	532
435	533
436	536
437	537
438	538
439	539
440	541
441	542
442	543
443	546
444	547
445	-
446	548
447	549
448	550
449	551
450	552

451	553
452	554
453	555
454	556
455	557
456	558
457	559
458	560
459	561
460	562
461	563
462	564
463	565
464	-
465	566
466	567
467	570
468	571
469	572
470	573
471	574
472	575
473	576
SS6	TS-R-1
474	577
475	578
476	579
477	580
478	-
479	568
480	569
481	-
482	-
483	581
484	582
501	601
502	602
503	603
504	604
505	606
506	607
507	608
508	609
509	610
510	611
511	612
512	613
513	614
514	616
515	617
516	618
517	619
518	621
519	622
520	623
521	625
522	626
523	627
524	633
525	634
526	635
527	636
528	637
529	638
530	639
531	640

532	641
533	642
534	643
535	644
536	645
537	646
538	647
539	648
540	649
541	650
542	656
SS6	TS-R-1
543	651
544	652
545	653
546	654
547	655
548	656
549	-
550	657
551	658
552	659
553	660
554	661
555	662
556	664
557	665
558	666
559	671
560	672
561	-
562	671
563	-
564	-
565	-
566	-
567	-
568	673
568	674
601	701
602	702
603	703
604	704
605	704
606	704
607	705
608	706
609	707
610	708
611	709
612	710
613	711
614	713
615	714
616	715
617	716
618	717
619	719
620	720
621	721
622	722
623	723
624	724
625	725
626	726
SS6	TS-R-1

627	727
628	728
629	729
630	730
631	731
632	732
633	733
701	802
702	803
703	804
704	806
705	807
706	808
707	809
708	810
709	811
710	812
711	813
712	814
713	816
714	817
715	819
716	820
717	821
718	822
719	823
720	824
721	825
722	826
723	827
724	828
725	829
726	830
727	831
728	832
729	833
730	834

Table 6.2
Correspondence of
paragraph numbers between
TS-R-1 and SS6

TS-R-1	SS6
-	109
-	147
-	201
-	202
-	204
-	314
-	417
-	424
-	431
-	445
-	464
-	478
-	481
-	482
-	549
-	561
-	563
-	564
-	565
-	566
-	567
101	101
102	-
103	108
104	-
105	107
106	102
107	103
108	104
109	105
110	-
201	110
202	111
203	112
204	113
205	114
206	115
207	116
208	117
209	-
210	118
211	119
212	120
213	121
214	122
215	124
216	123
217	125
218	-
219	126
220	127
TS-R-1	SS6

221	128
222	129
223	130
224	-
225	-
226	131
227	-
228	132
229	133
230	134
231	135
232	136
233	137
234	-
235	138
236	139
237	140
238	141
239	142
240	143
241	144
242	145
243	146
244	148
245	149
246	150
247	151
248	152
301	-
302	-
303	-
304	203
305	-
306	205
307	206
308	207
309	208
310	209
311	210
312	211
401	301
402	302
403	303
404	304
405	305
406	306
407	307
408	308
409	309
410	310
411	311
TS-R-1	SS6
412	-
413	312
414	-
415	313
416	-
417	-
418	315
419	-
501	401

502	402
503	403
504	404
505	405
506	406
507	407
508	408
509	409
510	410
511	411
512	412
513	413
514	414
515	415
516	416
517	418
518	419
519	420
520	421
521	422
522	423
523	425
524	426
525	427
526	428
527	430
528	429
529	-
530	432
531	433
532	434
533	435
534	-
535	-
536	436
537	437
538	438
539	439
540	-
541	440
542	441
543	442
TS-R-1	SS6
544	-
545	-
546	443
547	444
548	446
549	447
550	448
551	449
552	450
553	451
554	452
555	453
556	454
557	455
558	456
559	457
560	458
561	459

562	460
563	461
564	462
565	463
566	465
567	466
568	479
569	480
570	467
571	468
572	469
573	470
574	471
575	472
576	473
577	474
578	475
579	476
580	477
581	483
582	484
601	501
602	502
603	503
604	504
605	-
606	505
607	506
608	507
609	508
610	509
611	510
612	511
613	512
614	513
TS-R-1	SS6
615	-
616	514
617	515
618	516
619	517
620	-
621	518
622	519
623	520
624	-
625	521
626	522
627	523
628	-
629	-
630	-
631	-
632	-
633	524
634	525
635	526
636	527
637	528
638	529
639	530

640	531
641	532
642	533
643	534
644	535
645	536
646	537
647	538
648	539
649	540
650	541
651	543
652	544
653	545
654	546
655	547
656	542
656	548
657	550
658	551
659	552
660	553
661	554
662	555
663	-
664	556
665	557
666	558
TS-R-1	SS6
667	-
668	-
669	-
670	-
671	559
671	562
672	560
673	568
674	568
675	-
676	-
677	-
678	-
679	-
680	-
681	-
682	-
701	601
702	602
703	603
704	604
704	605
704	606
705	607
706	608
707	609
708	610
709	611
710	612
711	613
712	-
713	614

714	615
715	616
716	617
717	618
718	-
719	619
720	620
721	621
722	622
723	623
724	624
725	625
726	626
727	627
728	628
729	629
730	630
731	631
732	632
733	633
734	-
TS-R-1	SS6
735	-
736	-
737	-
801	-
802	701
803	702
804	703
805	-
806	704
807	705
808	706
809	707
810	708
811	709
812	710
813	711
814	712
815	-
816	713
817	714
818	-
819	715
820	716
821	717
822	718
823	719
824	720
825	721
826	722
827	723
828	724
829	725
830	726
831	727
832	728
833	729
834	730

Table 6.3 Correspondence between “old” and “new” Schedule Numbers, UN Numbers, Proper Shipping Names and descriptions.

"Old" Schedule	"Old" UN Number	"Old" P.S.N. and Description	Subsidiary Risk	"New" Schedule	"New" UN Number	"New" P.S.N. and Description	Subsidiary risk
1	2910	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, LIMITED QUANTITY OF MATERIAL.		1	2910	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - LIMITED QUANTITY OF MATERIAL	
2	2910	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, INSTRUMENTS or ARTICLES.		2	2911	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - INSTRUMENTS or ARTICLES	
3	2910	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, ARTICLES MANUFACTURED FROM NATURAL URANIUM or DEPLETED URANIUM or NATURAL THORIUM.		3	2909	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - ARTICLES MANUFACTURED FROM NATURAL URANIUM or DEPLETED URANIUM or NATURAL THORIUM	
4	2910	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, EMPTY PACKAGING		4	2908	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - EMPTY PACKAGING	
5	2912	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA), N.O.S.		5	2912	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-I) non fissile or fissile-excepted	
6	2912	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA), N.O.S.		6	3321	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II) non fissile or fissile-excepted	
7	2912	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA), N.O.S.		7	3322	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-III) non fissile or fissile-excepted	
8	2913	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO)		8	2913	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-I or SCO-II) non fissile or fissile-excepted	
9	Various	As appropriate to the material		9	2915	RADIOACTIVE MATERIAL, TYPE A PACKAGE, non-special form, non fissile or fissile-excepted	
9	Various	As appropriate to the material		9	3332	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM non fissile or fissile-excepted	
10	Various	As appropriate to the material		10	2916	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, non fissile or fissile-excepted	
11	Various	As appropriate to the material		11	2917	RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, non fissile or fissile-excepted	
-	-	-		12	3323	RADIOACTIVE MATERIAL, TYPE C PACKAGE, non fissile or fissile-excepted	
13	Various	As appropriate to the material		14	2919	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, non fissile or fissile-excepted	
*	2978	URANIUM HEXAFLUORIDE, fissile excepted or non-fissile	Corrosive (UN Class 8)	*	2978	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE non fissile or fissile-excepted	Corrosive (UN Class 8)
6 + 12	2918	RADIOACTIVE MATERIAL, FISSILE, N.O.S.		6+13	3324	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), FISSILE	
7 + 12	2918	RADIOACTIVE MATERIAL, FISSILE, N.O.S.		7+13	3325	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-III), FISSILE	
8 + 12	2918	RADIOACTIVE MATERIAL, FISSILE, N.O.S.		8+13	3326	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-I or SCO-II), FISSILE	

"Old" Schedule	"Old" UN Number	"Old" P.S.N. and Description	Subsidiary Risk	"New" Schedule	"New" UN Number	"New" P.S.N. and Description	Subsidiary risk
9 + 12	2918	RADIOACTIVE MATERIAL, FISSILE, N.O.S.		9+13	3327	RADIOACTIVE MATERIAL, TYPE A PACKAGE, FISSILE non-special form	
9 + 12	2918	RADIOACTIVE MATERIAL, FISSILE, N.O.S.		9+13	3333	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM, FISSILE	
10 + 12	2918	RADIOACTIVE MATERIAL, FISSILE, N.O.S.		10+13	3328	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, FISSILE	
11 + 12	2918	RADIOACTIVE MATERIAL, FISSILE, N.O.S.		11+13	3329	RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, FISSILE	
-	-	-		12+13	3330	RADIOACTIVE MATERIAL, TYPE C PACKAGE, FISSILE	
13 + 12	2918	RADIOACTIVE MATERIAL, FISSILE, N.O.S.		14+13	3331	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, FISSILE	
* + 12	2977	URANIUM HEXAFLUORIDE, FISSILE containing more than 1.0 per cent uranium-235	Corrosive (UN Class 8)	*+13	2977	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSILE	corrosive (UN Class 8)
* + 12	2918	RADIOACTIVE MATERIAL, FISSILE, N.O.S.		* + 13	As appropriate to package	As appropriate to package	
*	2974	RADIOACTIVE MATERIAL, SPECIAL FORM, N.O.S.		*	As appropriate to package	As appropriate to package	
*	2975	THORIUM METAL, PYROPHORIC	Liable to spontaneous combustion	*	As appropriate to package	As appropriate to package	
*	2976	THORIUM NITRATE, SOLID	Oxidizing substance	*	As appropriate to package	As appropriate to package	
*	2979	URANIUM METAL, PYROPHORIC	Liable to spontaneous combustion	*	As appropriate to package	As appropriate to package	
*	2980	URANYL NITRATE HEXAHYDRATE SOLUTION	Corrosive	*	As appropriate to package	As appropriate to package	
*	2981	URANYL NITRATE, SOLID	Oxidizing substance	*	As appropriate to package	As appropriate to package	
*	2982	RADIOACTIVE MATERIAL, N.O.S.		*	As appropriate to package	As appropriate to package	

* These materials are special cases without a unique relationship with the Schedules. The package type in which the material is carried determines the appropriate Schedule.

Table 6.4 Comparison of SS6 A₁/A₂ Values with TS-R-1 Values

[Note, row in grey tone indicate reduced A₂ values from the 1985 to the 1996 Edition of the Regulations.]

Comparison of SS6 A ₁ /A ₂ Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁	A ₂		A ₁	A ₂	A ₁	A ₂
(TBq)	(TBq)		(TBq)	(TBq)		
6.00E-01	1.00E-02	Ac-225	8.00E-01	6.00E-03	1.33E+00	6.00E-01
4.00E+01	2.00E-05	Ac-227	9.00E-01	9.00E-05	2.25E-02	4.50E+00
6.00E-01	4.00E-01	Ac-228	6.00E-01	5.00E-01	1.00E+00	1.25E+00
2.00E+00	2.00E+00	Ag-105	2.00E+00	2.00E+00	1.00E+00	1.00E+00
6.00E-01	6.00E-01	Ag-108m	7.00E-01	7.00E-01	1.17E+00	1.17E+00
4.00E-01	4.00E-01	Ag-110m	4.00E-01	4.00E-01	1.00E+00	1.00E+00
6.00E-01	5.00E-01	Ag-111	2.00E+00	6.00E-01	3.33E+00	1.20E+00
4.00E-01	4.00E-01	Al-26	1.00E-01	1.00E-01	2.50E-01	2.50E-01
2.00E+00	2.00E-04	Am-241	1.00E+01	1.00E-03	5.00E+00	5.00E+00
2.00E+00	2.00E-04	Am-242m	1.00E+01	1.00E-03	5.00E+00	5.00E+00
2.00E+00	2.00E-04	Am-243	5.00E+00	1.00E-03	2.50E+00	5.00E+00
		Ar-37	4.00E+01	4.00E+01		
		Ar-39	4.00E+01	2.00E+01		
		Ar-41	3.00E-01	3.00E-01		
2.00E-01	2.00E-01	As-72	3.00E-01	3.00E-01	1.50E+00	1.50E+00
4.00E+01	4.00E+01	As-73	4.00E+01	4.00E+01	1.00E+00	1.00E+00
1.00E+00	5.00E-01	As-74	1.00E+00	9.00E-01	1.00E+00	1.80E+00
2.00E-01	2.00E-01	As-76	3.00E-01	3.00E-01	1.50E+00	1.50E+00
2.00E+01	5.00E-01	As-77	2.00E+01	7.00E-01	1.00E+00	1.40E+00
3.00E+01	2.00E+00	At-211	2.00E+01	5.00E-01	6.67E-01	2.50E-01
6.00E+00	6.00E+00	Au-193	7.00E+00	2.00E+00	1.17E+00	3.33E-01

Comparison of SS6 A1/A2 Values with TS-R-1 Values							
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value		
A ₁	A ₂		A ₁	A ₂	A ₁	A ₂	
(TBq)	(TBq)		(TBq)	(TBq)			
1.00E+00	1.00E+00	Au-194	1.00E+00	1.00E+00	1.00E+00	1.00E+00	
1.00E+01	1.00E+01	Au-195	1.00E+01	6.00E+00	1.00E+00	6.00E-01	
3.00E+00	5.00E-01	Au-198	1.00E+00	6.00E-01	3.33E-01	1.20E+00	
1.00E+01	9.00E-01	Au-199	1.00E+01	6.00E-01	1.00E+00	6.67E-01	
2.00E+00	2.00E+00	Ba-131	2.00E+00	2.00E+00	1.00E+00	1.00E+00	
3.00E+00	3.00E+00	Ba-133	3.00E+00	3.00E+00	1.00E+00	1.00E+00	
1.00E+01	9.00E-01	Ba-133m	2.00E+01	6.00E-01	2.00E+00	6.67E-01	
4.00E-01	4.00E-01	Ba-140	5.00E-01	3.00E-01	1.25E+00	7.50E-01	
2.00E+01	5.00E-01	Be-10	4.00E+01	6.00E-01	2.00E+00	1.20E+00	
2.00E+01	2.00E+01	Be-7	2.00E+01	2.00E+01	1.00E+00	1.00E+00	
6.00E-01	6.00E-01	Bi-205	7.00E-01	7.00E-01	1.17E+00	1.17E+00	
3.00E-01	3.00E-01	Bi-206	3.00E-01	3.00E-01	1.00E+00	1.00E+00	
7.00E-01	7.00E-01	Bi-207	7.00E-01	7.00E-01	1.00E+00	1.00E+00	
6.00E-01	5.00E-01	Bi-210	1.00E+00	6.00E-01	1.67E+00	1.20E+00	
3.00E-01	3.00E-02	Bi-210m	6.00E-01	2.00E-02	2.00E+00	6.67E-01	
3.00E-01	3.00E-01	Bi-212	7.00E-01	6.00E-01	2.33E+00	2.00E+00	
2.00E+00	2.00E-04	Bk-247	8.00E+00	8.00E-04	4.00E+00	4.00E+00	
4.00E+01	8.00E-02	Bk-249	4.00E+01	3.00E-01	1.00E+00	3.75E+00	
3.00E-01	3.00E-01	Br-76	4.00E-01	4.00E-01	1.33E+00	1.33E+00	
3.00E+00	3.00E+00	Br-77	3.00E+00	3.00E+00	1.00E+00	1.00E+00	
4.00E-01	4.00E-01	Br-82	4.00E-01	4.00E-01	1.00E+00	1.00E+00	
1.00E+00	5.00E-01	C-11	1.00E+00	6.00E-01	1.00E+00	1.20E+00	
4.00E+01	2.00E+00	C-14	4.00E+01	3.00E+00	1.00E+00	1.50E+00	
4.00E+01	4.00E+01	Ca-41	Unlimited	Unlimited	∞	∞	
4.00E+01	9.00E-01	Ca-45	4.00E+01	1.00E+00	1.00E+00	1.11E+00	

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁ (TBq)	A ₂ (TBq)		A ₁ (TBq)	A ₂ (TBq)	A ₁	A ₂
9.00E-01	5.00E-01	Ca-47	3.00E+00	3.00E-01	3.33E+00	6.00E-01
4.00E+01	1.00E+00	Cd-109	3.00E+01	2.00E+00	7.50E-01	2.00E+00
2.00E+01	9.00E-02	Cd-113m	4.00E+01	5.00E-01	2.00E+00	5.56E+00
4.00E+00	5.00E-01	Cd-115	3.00E+00	4.00E-01	7.50E-01	8.00E-01
3.00E-01	3.00E-01	Cd-115m	5.00E-01	5.00E-01	1.67E+00	1.67E+00
6.00E+00	6.00E+00	Ce-139	7.00E+00	2.00E+00	1.17E+00	3.33E-01
1.00E+01	5.00E-01	Ce-141	2.00E+01	6.00E-01	2.00E+00	1.20E+00
6.00E-01	5.00E-01	Ce-143	9.00E-01	6.00E-01	1.50E+00	1.20E+00
2.00E-01	2.00E-01	Ce-144	2.00E-01	2.00E-01	1.00E+00	1.00E+00
3.00E+01	3.00E-03	Cf-248	4.00E+01	6.00E-03	1.33E+00	2.00E+00
2.00E+00	2.00E-04	Cf-249	3.00E+00	8.00E-04	1.50E+00	4.00E+00
5.00E+00	5.00E-04	Cf-250	2.00E+01	2.00E-03	4.00E+00	4.00E+00
2.00E+00	2.00E-04	Cf-251	7.00E+00	7.00E-04	3.50E+00	3.50E+00
1.00E-01	1.00E-03	Cf-252	5.00E-02	3.00E-03	5.00E-01	3.00E+00
4.00E+01	6.00E-02	Cf-253	4.00E+01	4.00E-02	1.00E+00	6.67E-01
3.00E-03	6.00E-04	Cf-254	1.00E-03	1.00E-03	3.33E-01	1.67E+00
2.00E+01	5.00E-01	Cl-36	1.00E+01	6.00E-01	5.00E-01	1.20E+00
2.00E-01	2.00E-01	Cl-38	2.00E-01	2.00E-01	1.00E+00	1.00E+00
4.00E+01	2.00E-02	Cm-240	4.00E+01	2.00E-02	1.00E+00	1.00E+00
2.00E+00	9.00E-01	Cm-241	2.00E+00	1.00E+00	1.00E+00	1.11E+00
4.00E+01	1.00E-02	Cm-242	4.00E+01	1.00E-02	1.00E+00	1.00E+00
3.00E+00	3.00E-04	Cm-243	9.00E+00	1.00E-03	3.00E+00	3.33E+00
4.00E+00	4.00E-04	Cm-244	2.00E+01	2.00E-03	5.00E+00	5.00E+00
2.00E+00	2.00E-04	Cm-245	9.00E+00	9.00E-04	4.50E+00	4.50E+00
2.00E+00	2.00E-04	Cm-246	9.00E+00	9.00E-04	4.50E+00	4.50E+00

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁	A ₂		A ₁	A ₂	A ₁	A ₂
(TBq)	(TBq)		(TBq)	(TBq)		
2.00E+00	2.00E-04	Cm-247	3.00E+00	1.00E-03	1.50E+00	5.00E+00
4.00E-02	5.00E-05	Cm-248	2.00E-02	3.00E-04	5.00E-01	6.00E+00
5.00E-01	5.00E-01	Co-55	5.00E-01	5.00E-01	1.00E+00	1.00E+00
3.00E-01	3.00E-01	Co-56	3.00E-01	3.00E-01	1.00E+00	1.00E+00
8.00E+00	8.00E+00	Co-57	1.00E+01	1.00E+01	1.25E+00	1.25E+00
1.00E+00	1.00E+00	Co-58	1.00E+00	1.00E+00	1.00E+00	1.00E+00
4.00E+01	4.00E+01	Co-58m	4.00E+01	4.00E+01	1.00E+00	1.00E+00
4.00E-01	4.00E-01	Co-60	4.00E-01	4.00E-01	1.00E+00	1.00E+00
3.00E+01	3.00E+01	Cr-51	3.00E+01	3.00E+01	1.00E+00	1.00E+00
4.00E+00	4.00E+00	Cs-129	4.00E+00	4.00E+00	1.00E+00	1.00E+00
4.00E+01	4.00E+01	Cs-131	3.00E+01	3.00E+01	7.50E-01	7.50E-01
1.00E+00	1.00E+00	Cs-132	1.00E+00	1.00E+00	1.00E+00	1.00E+00
6.00E-01	5.00E-01	Cs-134	7.00E-01	7.00E-01	1.17E+00	1.40E+00
4.00E+01	9.00E+00	Cs-134m	4.00E+01	6.00E-01	1.00E+00	6.67E-02
4.00E+01	9.00E-01	Cs-135	4.00E+01	1.00E+00	1.00E+00	1.11E+00
5.00E-01	5.00E-01	Cs-136	5.00E-01	5.00E-01	1.00E+00	1.00E+00
2.00E+00	5.00E-01	Cs-137	2.00E+00	6.00E-01	1.00E+00	1.20E+00
5.00E+00	9.00E-01	Cu-64	6.00E+00	1.00E+00	1.20E+00	1.11E+00
9.00E+00	9.00E-01	Cu-67	1.00E+01	7.00E-01	1.11E+00	7.78E-01
		Dy-159	2.00E+01	2.00E+01		
6.00E-01	5.00E-01	Dy-165	9.00E-01	6.00E-01	1.50E+00	1.20E+00
3.00E-01	3.00E-01	Dy-166	9.00E-01	3.00E-01	3.00E+00	1.00E+00
4.00E+01	9.00E-01	Er-169	4.00E+01	1.00E+00	1.00E+00	1.11E+00
6.00E-01	5.00E-01	Er-171	8.00E-01	5.00E-01	1.33E+00	1.00E+00
2.00E+00	2.00E+00	Eu-147	2.00E+00	2.00E+00	1.00E+00	1.00E+00

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁	A ₂		A ₁	A ₂	A ₁	A ₂
(TBq)	(TBq)		(TBq)	(TBq)		
5.00E-01	5.00E-01	Eu-148	5.00E-01	5.00E-01	1.00E+00	1.00E+00
2.00E+01	2.00E+01	Eu-149	2.00E+01	2.00E+01	1.00E+00	1.00E+00
7.00E-01	7.00E-01	Eu-150				
		Eu-150(long-lived)	7.00E-01	7.00E-01		
		Eu-150(short-lived)	2.00E+00	7.00E-01		
9.00E-01	9.00E-01	Eu-152	1.00E+00	1.00E+00	1.11E+00	1.11E+00
6.00E-01	5.00E-01	Eu-152m	8.00E-01	8.00E-01	1.33E+00	1.60E+00
8.00E-01	5.00E-01	Eu-154	9.00E-01	6.00E-01	1.13E+00	1.20E+00
2.00E+01	2.00E+00	Eu-155	2.00E+01	3.00E+00	1.00E+00	1.50E+00
6.00E-01	5.00E-01	Eu-156	7.00E-01	7.00E-01	1.17E+00	1.40E+00
1.00E+00	5.00E-01	F-18	1.00E+00	6.00E-01	1.00E+00	1.20E+00
2.00E-01	2.00E-01	Fe-52	3.00E-01	3.00E-01	1.50E+00	1.50E+00
4.00E+01	4.00E+01	Fe-55	4.00E+01	4.00E+01	1.00E+00	1.00E+00
8.00E-01	8.00E-01	Fe-59	9.00E-01	9.00E-01	1.13E+00	1.13E+00
4.00E+01	2.00E-01	Fe-60	4.00E+01	2.00E-01	1.00E+00	1.00E+00
6.00E+00	6.00E+00	Ga-67	7.00E+00	3.00E+00	1.17E+00	5.00E-01
3.00E-01	3.00E-01	Ga-68	5.00E-01	5.00E-01	1.67E+00	1.67E+00
4.00E-01	4.00E-01	Ga-72	4.00E-01	4.00E-01	1.00E+00	1.00E+00
4.00E-01	4.00E-01	Gd-146	5.00E-01	5.00E-01	1.25E+00	1.25E+00
		Gd-148	2.00E+01	2.00E-03		
1.00E+01	5.00E+00	Gd-153	1.00E+01	9.00E+00	1.00E+00	1.80E+00
4.00E+00	5.00E-01	Gd-159	3.00E+00	6.00E-01	7.50E-01	1.20E+00
3.00E-01	3.00E-01	Ge-68	5.00E-01	5.00E-01	1.67E+00	1.67E+00
4.00E+01	4.00E+01	Ge-71	4.00E+01	4.00E+01	1.00E+00	1.00E+00
3.00E-01	3.00E-01	Ge-77	3.00E-01	3.00E-01	1.00E+00	1.00E+00

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁ (TBq)	A ₂ (TBq)		A ₁ (TBq)	A ₂ (TBq)	A ₁	A ₂
5.00E-01	3.00E-01	Hf-172	6.00E-01	6.00E-01	1.20E+00	2.00E+00
3.00E+00	3.00E+00	Hf-175	3.00E+00	3.00E+00	1.00E+00	1.00E+00
2.00E+00	9.00E-01	Hf-181	2.00E+00	5.00E-01	1.00E+00	5.56E-01
4.00E+00	3.00E-02	Hf-182	Unlimited	Unlimited	∞	∞
1.00E+00	1.00E+00	Hg-194	1.00E+00	1.00E+00	1.00E+00	1.00E+00
5.00E+00	5.00E+00	Hg-195m	3.00E+00	7.00E-01	6.00E-01	1.40E-01
1.00E+01	1.00E+01	Hg-197	2.00E+01	1.00E+01	2.00E+00	1.00E+00
1.00E+01	9.00E-01	Hg-197m	1.00E+01	4.00E-01	1.00E+00	4.44E-01
4.00E+00	9.00E-01	Hg-203	5.00E+00	1.00E+00	1.25E+00	1.11E+00
3.00E-01	3.00E-01	Ho-166	4.00E-01	4.00E-01	1.33E+00	1.33E+00
6.00E-01	3.00E-01	Ho-166m	6.00E-01	5.00E-01	1.00E+00	1.67E+00
6.00E+00	6.00E+00	I-123	6.00E+00	3.00E+00	1.00E+00	5.00E-01
9.00E-01	9.00E-01	I-124	1.00E+00	1.00E+00	1.11E+00	1.11E+00
2.00E+01	2.00E+00	I-125	2.00E+01	3.00E+00	1.00E+00	1.50E+00
2.00E+00	9.00E-01	I-126	2.00E+00	1.00E+00	1.00E+00	1.11E+00
		I-129	Unlimited	Unlimited		
3.00E+00	5.00E-01	I-131	3.00E+00	7.00E-01	1.00E+00	1.40E+00
4.00E-01	4.00E-01	I-132	4.00E-01	4.00E-01	1.00E+00	1.00E+00
6.00E-01	5.00E-01	I-133	7.00E-01	6.00E-01	1.17E+00	1.20E+00
3.00E-01	3.00E-01	I-134	3.00E-01	3.00E-01	1.00E+00	1.00E+00
6.00E-01	5.00E-01	I-135	6.00E-01	6.00E-01	1.00E+00	1.20E+00
2.00E+00	2.00E+00	In-111	3.00E+00	3.00E+00	1.50E+00	1.50E+00
4.00E+00	4.00E+00	In-113m	4.00E+00	2.00E+00	1.00E+00	5.00E-01
3.00E-01	3.00E-01	In-114m	1.00E+01	5.00E-01	3.33E+01	1.67E+00
6.00E+00	9.00E-01	In-115m	7.00E+00	1.00E+00	1.17E+00	1.11E+00

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁	A ₂		A ₁	A ₂	A ₁	A ₂
(TBq)	(TBq)		(TBq)	(TBq)		
1.00E+01	1.00E+01	Ir-189	1.00E+01	1.00E+01	1.00E+00	1.00E+00
7.00E-01	7.00E-01	Ir-190	7.00E-01	7.00E-01	1.00E+00	1.00E+00
1.00E+00	5.00E-01	Ir-192	1.00E+00	6.00E-01	1.00E+00	1.20E+00
2.00E-01	2.00E-01	Ir-194	3.00E-01	3.00E-01	1.50E+00	1.50E+00
		K-40	9.00E-01	9.00E-01		
2.00E-01	2.00E-01	K-42	2.00E-01	2.00E-01	1.00E+00	1.00E+00
1.00E+00	5.00E-01	K-43	7.00E-01	6.00E-01	7.00E-01	1.20E+00
		Kr-81	4.00E+01	4.00E+01		
		Kr-85	1.00E+01	1.00E+01		
		Kr-85m	8.00E+00	3.00E+00		
		Kr-87	2.00E-01	2.00E-01		
4.00E+01	2.00E+00	La-137	3.00E+01	6.00E+00	7.50E-01	3.00E+00
4.00E-01	4.00E-01	La-140	4.00E-01	4.00E-01	1.00E+00	1.00E+00
5.00E-01	5.00E-01	Lu-172	6.00E-01	6.00E-01	1.20E+00	1.20E+00
8.00E+00	8.00E+00	Lu-173	8.00E+00	8.00E+00	1.00E+00	1.00E+00
8.00E+00	4.00E+00	Lu-174	9.00E+00	9.00E+00	1.13E+00	2.25E+00
2.00E+01	8.00E+00	Lu-174m	2.00E+01	1.00E+01	1.00E+00	1.25E+00
3.00E+01	9.00E-01	Lu-177	3.00E+01	7.00E-01	1.00E+00	7.78E-01
2.00E-01	2.00E-01	Mg-28	3.00E-01	3.00E-01	1.50E+00	1.50E+00
3.00E-01	3.00E-01	Mn-52	3.00E-01	3.00E-01	1.00E+00	1.00E+00
		Mn-53	Unlimited	Unlimited		
1.00E+00	1.00E+00	Mn-54	1.00E+00	1.00E+00	1.00E+00	1.00E+00
2.00E-01	2.00E-01	Mn-56	3.00E-01	3.00E-01	1.50E+00	1.50E+00
4.00E+01	7.00E+00	Mo-93	4.00E+01	2.00E+01	1.00E+00	2.86E+00
6.00E-01	5.00E-01	Mo-99	1.00E+00	6.00E-01	1.67E+00	1.20E+00

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁	A ₂		A ₁	A ₂	A ₁	A ₂
(TBq)	(TBq)		(TBq)	(TBq)		
		N-13	9.00E-01	6.00E-01		
5.00E-01	5.00E-01	Na-22	5.00E-01	5.00E-01	1.00E+00	1.00E+00
2.00E-01	2.00E-01	Na-24	2.00E-01	2.00E-01	1.00E+00	1.00E+00
4.00E+01	6.00E+00	Nb-93m	4.00E+01	3.00E+01	1.00E+00	5.00E+00
6.00E-01	6.00E-01	Nb-94	7.00E-01	7.00E-01	1.17E+00	1.17E+00
1.00E+00	1.00E+00	Nb-95	1.00E+00	1.00E+00	1.00E+00	1.00E+00
6.00E-01	5.00E-01	Nb-97	9.00E-01	6.00E-01	1.50E+00	1.20E+00
4.00E+00	5.00E-01	Nd-147	6.00E+00	6.00E-01	1.50E+00	1.20E+00
6.00E-01	5.00E-01	Nd-149	6.00E-01	5.00E-01	1.00E+00	1.00E+00
4.00E+01	4.00E+01	Ni-59	Unlimited	Unlimited	∞	∞
4.00E+01	3.00E+01	Ni-63	4.00E+01	3.00E+01	1.00E+00	1.00E+00
3.00E-01	3.00E-01	Ni-65	4.00E-01	4.00E-01	1.33E+00	1.33E+00
4.00E+01	4.00E+01	Np-235	4.00E+01	4.00E+01	1.00E+00	1.00E+00
7.00E+00	1.00E-03	Np-236				
		Np-236(long-lived)	9.00E+00	2.00E-02		
		Np-236(short-lived)	2.00E+01	2.00E+00		
2.00E+00	2.00E-04	Np-237	2.00E+01	2.00E-03	1.00E+01	1.00E+01
6.00E+00	5.00E-01	Np-239	7.00E+00	4.00E-01	1.17E+00	8.00E-01
1.00E+00	1.00E+00	Os-185	1.00E+00	1.00E+00	1.00E+00	1.00E+00
4.00E+01	4.00E+01	Os-191	1.00E+01	2.00E+00	2.50E-01	5.00E-02
1.00E+01	9.00E-01	Os-191m	4.00E+01	3.00E+01	4.00E+00	3.33E+01
6.00E-01	5.00E-01	Os-193	2.00E+00	6.00E-01	3.33E+00	1.20E+00
2.00E-01	2.00E-01	Os-194	3.00E-01	3.00E-01	1.50E+00	1.50E+00
3.00E-01	3.00E-01	P-32	5.00E-01	5.00E-01	1.67E+00	1.67E+00
4.00E+01	9.00E-01	P-33	4.00E+01	1.00E+00	1.00E+00	1.11E+00

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁ (TBq)	A ₂ (TBq)		A ₁ (TBq)	A ₂ (TBq)	A ₁	A ₂
2.00E+00	1.00E-01	Pa-230	2.00E+00	7.00E-02	1.00E+00	7.00E-01
6.00E-01	6.00E-05	Pa-231	4.00E+00	4.00E-04	6.67E+00	6.67E+00
5.00E+00	9.00E-01	Pa-233	5.00E+00	7.00E-01	1.00E+00	7.78E-01
1.00E+00	1.00E+00	Pb-201	1.00E+00	1.00E+00	1.00E+00	1.00E+00
4.00E+01	2.00E+00	Pb-202	4.00E+01	2.00E+01	1.00E+00	1.00E+01
3.00E+00	3.00E+00	Pb-203	4.00E+00	3.00E+00	1.33E+00	1.00E+00
		Pb-205	Unlimited	Unlimited		
6.00E-01	9.00E-03	Pb-210	1.00E+00	5.00E-02	1.67E+00	5.56E+00
3.00E-01	3.00E-01	Pb-212	7.00E-01	2.00E-01	2.33E+00	6.67E-01
4.00E+01	4.00E+01	Pd-103	4.00E+01	4.00E+01	1.00E+00	1.00E+00
		Pd-107	Unlimited	Unlimited		
6.00E-01	5.00E-01	Pd-109	2.00E+00	5.00E-01	3.33E+00	1.00E+00
3.00E+00	3.00E+00	Pm-143	3.00E+00	3.00E+00	1.00E+00	1.00E+00
6.00E-01	6.00E-01	Pm-144	7.00E-01	7.00E-01	1.17E+00	1.17E+00
3.00E+01	7.00E+00	Pm-145	3.00E+01	1.00E+01	1.00E+00	1.43E+00
4.00E+01	9.00E-01	Pm-147	4.00E+01	2.00E+00	1.00E+00	2.22E+00
5.00E-01	5.00E-01	Pm-148m	8.00E-01	7.00E-01	1.60E+00	1.40E+00
6.00E-01	5.00E-01	Pm-149	2.00E+00	6.00E-01	3.33E+00	1.20E+00
3.00E+00	5.00E-01	Pm-151	2.00E+00	6.00E-01	6.67E-01	1.20E+00
4.00E+01	2.00E-02	Po-210	4.00E+01	2.00E-02	1.00E+00	1.00E+00
2.00E-01	2.00E-01	Pr-142	4.00E-01	4.00E-01	2.00E+00	2.00E+00
4.00E+00	5.00E-01	Pr-143	3.00E+00	6.00E-01	7.50E-01	1.20E+00
6.00E-01	6.00E-01	Pt-188	1.00E+00	8.00E-01	1.67E+00	1.33E+00
3.00E+00	3.00E+00	Pt-191	4.00E+00	3.00E+00	1.33E+00	1.00E+00
4.00E+01	4.00E+01	Pt-193	4.00E+01	4.00E+01	1.00E+00	1.00E+00

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁ (TBq)	A ₂ (TBq)		A ₁ (TBq)	A ₂ (TBq)	A ₁	A ₂
4.00E+01	9.00E+00	Pt-193m	4.00E+01	5.00E-01	1.00E+00	5.56E-02
1.00E+01	2.00E+00	Pt-195m	2.00E+01	5.00E-01	2.00E+00	2.50E-01
2.00E+01	5.00E-01	Pt-197	2.00E+01	6.00E-01	1.00E+00	1.20E+00
1.00E+01	9.00E-01	Pt-197m	1.00E+01	6.00E-01	1.00E+00	6.67E-01
7.00E+00	7.00E-04	Pu-236	3.00E+01	3.00E-03	4.29E+00	4.29E+00
2.00E+01	2.00E+01	Pu-237	2.00E+01	2.00E+01	1.00E+00	1.00E+00
2.00E+00	2.00E-04	Pu-238	1.00E+01	1.00E-03	5.00E+00	5.00E+00
2.00E+00	2.00E-04	Pu-239	1.00E+01	1.00E-03	5.00E+00	5.00E+00
2.00E+00	2.00E-04	Pu-240	1.00E+01	1.00E-03	5.00E+00	5.00E+00
4.00E+01	1.00E-02	Pu-241	4.00E+01	6.00E-02	1.00E+00	6.00E+00
2.00E+00	2.00E-04	Pu-242	1.00E+01	1.00E-03	5.00E+00	5.00E+00
3.00E-01	2.00E-04	Pu-244	4.00E-01	1.00E-03	1.33E+00	5.00E+00
6.00E-01	3.00E-02	Ra-223	4.00E-01	7.00E-03	6.67E-01	2.33E-01
3.00E-01	6.00E-02	Ra-224	4.00E-01	2.00E-02	1.33E+00	3.33E-01
6.00E-01	2.00E-02	Ra-225	2.00E-01	4.00E-03	3.33E-01	2.00E-01
3.00E-01	2.00E-02	Ra-226	2.00E-01	3.00E-03	6.67E-01	1.50E-01
6.00E-01	4.00E-02	Ra-228	6.00E-01	2.00E-02	1.00E+00	5.00E-01
		Rb(nat)	Unlimited	Unlimited		
2.00E+00	9.00E-01	Rb-81	2.00E+00	8.00E-01	1.00E+00	8.89E-01
2.00E+00	2.00E+00	Rb-83	2.00E+00	2.00E+00	1.00E+00	1.00E+00
1.00E+00	9.00E-01	Rb-84	1.00E+00	1.00E+00	1.00E+00	1.11E+00
3.00E-01	3.00E-01	Rb-86	5.00E-01	5.00E-01	1.67E+00	1.67E+00
		Rb-87	Unlimited	Unlimited		
		Re(nat)	Unlimited	Unlimited		
1.00E+00	1.00E+00	Re-184	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁	A ₂		A ₁	A ₂	A ₁	A ₂
(TBq)	(TBq)		(TBq)	(TBq)		
3.00E+00	3.00E+00	Re-184m	3.00E+00	1.00E+00	1.00E+00	3.33E-01
4.00E+00	5.00E-01	Re-186	2.00E+00	6.00E-01	5.00E-01	1.20E+00
		Re-187	Unlimited	Unlimited		
2.00E-01	2.00E-01	Re-188	4.00E-01	4.00E-01	2.00E+00	2.00E+00
4.00E+00	5.00E-01	Re-189	3.00E+00	6.00E-01	7.50E-01	1.20E+00
4.00E+00	4.00E+00	Rh-101	4.00E+00	3.00E+00	1.00E+00	7.50E-01
5.00E-01	5.00E-01	Rh-102	5.00E-01	5.00E-01	1.00E+00	1.00E+00
2.00E+00	9.00E-01	Rh-102m	2.00E+00	2.00E+00	1.00E+00	2.22E+00
4.00E+01	4.00E+01	Rh-103m	4.00E+01	4.00E+01	1.00E+00	1.00E+00
1.00E+01	9.00E-01	Rh-105	1.00E+01	8.00E-01	1.00E+00	8.89E-01
2.00E+00	2.00E+00	Rh-99	2.00E+00	2.00E+00	1.00E+00	1.00E+00
		Rn-222	3.00E-01	4.00E-03		
2.00E+00	9.00E-01	Ru-103	2.00E+00	2.00E+00	1.00E+00	2.22E+00
6.00E-01	5.00E-01	Ru-105	1.00E+00	6.00E-01	1.67E+00	1.20E+00
2.00E-01	2.00E-01	Ru-106	2.00E-01	2.00E-01	1.00E+00	1.00E+00
4.00E+00	4.00E+00	Ru-97	5.00E+00	5.00E+00	1.25E+00	1.25E+00
4.00E+01	2.00E+00	S-35	4.00E+01	3.00E+00	1.00E+00	1.50E+00
3.00E-01	3.00E-01	Sb-122	4.00E-01	4.00E-01	1.33E+00	1.33E+00
6.00E-01	5.00E-01	Sb-124	6.00E-01	6.00E-01	1.00E+00	1.20E+00
2.00E+00	9.00E-01	Sb-125	2.00E+00	1.00E+00	1.00E+00	1.11E+00
4.00E-01	4.00E-01	Sb-126	4.00E-01	4.00E-01	1.00E+00	1.00E+00
5.00E-01	5.00E-01	Sc-44	5.00E-01	5.00E-01	1.00E+00	1.00E+00
5.00E-01	5.00E-01	Sc-46	5.00E-01	5.00E-01	1.00E+00	1.00E+00
9.00E+00	9.00E-01	Sc-47	1.00E+01	7.00E-01	1.11E+00	7.78E-01
3.00E-01	3.00E-01	Sc-48	3.00E-01	3.00E-01	1.00E+00	1.00E+00

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁	A ₂		A ₁	A ₂	A ₁	A ₂
(TBq)	(TBq)		(TBq)	(TBq)		
3.00E+00	3.00E+00	Se-75	3.00E+00	3.00E+00	1.00E+00	1.00E+00
4.00E+01	2.00E+00	Se-79	4.00E+01	2.00E+00	1.00E+00	1.00E+00
6.00E-01	5.00E-01	Si-31	6.00E-01	6.00E-01	1.00E+00	1.20E+00
4.00E+01	2.00E-01	Si-32	4.00E+01	5.00E-01	1.00E+00	2.50E+00
2.00E+01	2.00E+01	Sm-145	1.00E+01	1.00E+01	5.00E-01	5.00E-01
		Sm-147	Unlimited	Unlimited		
4.00E+01	4.00E+00	Sm-151	4.00E+01	1.00E+01	1.00E+00	2.50E+00
4.00E+00	5.00E-01	Sm-153	9.00E+00	6.00E-01	2.25E+00	1.20E+00
4.00E+00	4.00E+00	Sn-113	4.00E+00	2.00E+00	1.00E+00	5.00E-01
6.00E+00	2.00E+00	Sn-117m	7.00E+00	4.00E-01	1.17E+00	2.00E-01
4.00E+01	4.00E+01	Sn-119m	4.00E+01	3.00E+01	1.00E+00	7.50E-01
4.00E+01	9.00E-01	Sn-121m	4.00E+01	9.00E-01	1.00E+00	1.00E+00
6.00E-01	5.00E-01	Sn-123	8.00E-01	6.00E-01	1.33E+00	1.20E+00
2.00E-01	2.00E-01	Sn-125	4.00E-01	4.00E-01	2.00E+00	2.00E+00
3.00E-01	3.00E-01	Sn-126	6.00E-01	4.00E-01	2.00E+00	1.33E+00
2.00E-01	2.00E-01	Sr-82	2.00E-01	2.00E-01	1.00E+00	1.00E+00
2.00E+00	2.00E+00	Sr-85	2.00E+00	2.00E+00	1.00E+00	1.00E+00
5.00E+00	5.00E+00	Sr-85m	5.00E+00	5.00E+00	1.00E+00	1.00E+00
3.00E+00	3.00E+00	Sr-87m	3.00E+00	3.00E+00	1.00E+00	1.00E+00
6.00E-01	5.00E-01	Sr-89	6.00E-01	6.00E-01	1.00E+00	1.20E+00
2.00E-01	1.00E-01	Sr-90	3.00E-01	3.00E-01	1.50E+00	3.00E+00
3.00E-01	3.00E-01	Sr-91	3.00E-01	3.00E-01	1.00E+00	1.00E+00
2.00E-01	2.00E-01	Sr-92	1.00E+00	3.00E-01	5.00E+00	1.50E+00
		T(H-3)	4.00E+01	4.00E+01		
1.00E+00	1.00E+00	Ta-178				

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁	A ₂		A ₁	A ₂		
(TBq)	(TBq)		(TBq)	(TBq)	A ₁	A ₂
		Ta-178(long-lived)	1.00E+00	8.00E-01		
3.00E+01	3.00E+01	Ta-179	3.00E+01	3.00E+01	1.00E+00	1.00E+00
8.00E-01	5.00E-01	Ta-182	9.00E-01	5.00E-01	1.13E+00	1.00E+00
4.00E+01	1.00E+01	Tb-157	4.00E+01	4.00E+01	1.00E+00	4.00E+00
1.00E+00	7.00E-01	Tb-158	1.00E+00	1.00E+00	1.00E+00	1.43E+00
9.00E-01	5.00E-01	Tb-160	1.00E+00	6.00E-01	1.11E+00	1.20E+00
2.00E+00	2.00E+00	Tc-95m	2.00E+00	2.00E+00	1.00E+00	1.00E+00
4.00E-01	4.00E-01	Tc-96	4.00E-01	4.00E-01	1.00E+00	1.00E+00
4.00E-01	4.00E-01	Tc-96m	4.00E-01	4.00E-01	1.00E+00	1.00E+00
		Tc-97	Unlimited	Unlimited		
4.00E+01	4.00E+01	Tc-97m	4.00E+01	1.00E+00	1.00E+00	2.50E-02
7.00E-01	7.00E-01	Tc-98	8.00E-01	7.00E-01	1.14E+00	1.00E+00
4.00E+01	9.00E-01	Tc-99	4.00E+01	9.00E-01	1.00E+00	1.00E+00
8.00E+00	8.00E+00	Tc-99m	1.00E+01	4.00E+00	1.25E+00	5.00E-01
2.00E+00	2.00E+00	Te-121	2.00E+00	2.00E+00	1.00E+00	1.00E+00
5.00E+00	5.00E+00	Te-121m	5.00E+00	3.00E+00	1.00E+00	6.00E-01
7.00E+00	7.00E+00	Te-123m	8.00E+00	1.00E+00	1.14E+00	1.43E-01
3.00E+01	9.00E+00	Te-125m	2.00E+01	9.00E-01	6.67E-01	1.00E-01
2.00E+01	5.00E-01	Te-127	2.00E+01	7.00E-01	1.00E+00	1.40E+00
2.00E+01	5.00E-01	Te-127m	2.00E+01	5.00E-01	1.00E+00	1.00E+00
6.00E-01	5.00E-01	Te-129	7.00E-01	6.00E-01	1.17E+00	1.20E+00
6.00E-01	5.00E-01	Te-129m	8.00E-01	4.00E-01	1.33E+00	8.00E-01
7.00E-01	5.00E-01	Te-131m	7.00E-01	5.00E-01	1.00E+00	1.00E+00
4.00E-01	4.00E-01	Te-132	5.00E-01	4.00E-01	1.25E+00	1.00E+00
		Th(nat)	Unlimited	Unlimited		

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁	A ₂		A ₁	A ₂		
(TBq)	(TBq)		(TBq)	(TBq)	A ₁	A ₂
9.00E+00	1.00E-02	Th-227	1.00E+01	5.00E-03	1.11E+00	5.00E-01
3.00E-01	4.00E-04	Th-228	5.00E-01	1.00E-03	1.67E+00	2.50E+00
3.00E-01	3.00E-05	Th-229	5.00E+00	5.00E-04	1.67E+01	1.67E+01
2.00E+00	2.00E-04	Th-230	1.00E+01	1.00E-03	5.00E+00	5.00E+00
4.00E+01	9.00E-01	Th-231	4.00E+01	2.00E-02	1.00E+00	2.22E-02
Unlimited	Unlimited	Th-232	Unlimited	Unlimited	1.00E+00	1.00E+00
2.00E-01	2.00E-01	Th-234	3.00E-01	3.00E-01	1.50E+00	1.50E+00
5.00E-01	2.00E-01	Ti-44	5.00E-01	4.00E-01	1.00E+00	2.00E+00
8.00E-01	8.00E-01	Ti-200	9.00E-01	9.00E-01	1.13E+00	1.13E+00
1.00E+01	1.00E+01	Ti-201	1.00E+01	4.00E+00	1.00E+00	4.00E-01
2.00E+00	2.00E+00	Ti-202	2.00E+00	2.00E+00	1.00E+00	1.00E+00
4.00E+00	5.00E-01	Ti-204	1.00E+01	7.00E-01	2.50E+00	1.40E+00
7.00E+00	7.00E+00	Tm-167	7.00E+00	8.00E-01	1.00E+00	1.14E-01
4.00E+00	5.00E-01	Tm-170	3.00E+00	6.00E-01	7.50E-01	1.20E+00
4.00E+01	1.00E+01	Tm-171	4.00E+01	4.00E+01	1.00E+00	4.00E+00
		U(dep)	Unlimited	Unlimited		
		U(enriched to 20% or less)	Unlimited	Unlimited		
		U(nat)	Unlimited	Unlimited		
4.00E+01	1.00E-02	U-230				
		U-230 (fast lung absorption)	4.00E+01	1.00E-01		
		U-230 (medium lung absorption)	4.00E+01	4.00E-03		
		U-230 (slow lung absorption)	3.00E+01	3.00E-03		
3.00E+00	3.00E-04	U-232				
		U-232 (fast lung absorption)	4.00E+01	1.00E-02		
		U-232 (medium lung absorption)	4.00E+01	7.00E-03		

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁ (TBq)	A ₂ (TBq)		A ₁ (TBq)	A ₂ (TBq)	A ₁	A ₂
		U-232 (slow lung absorption)	1.00E+01	1.00E-03		
		U-233 (fast lung absorption)	4.00E+01	9.00E-02		
		U-233 (medium lung absorption)	4.00E+01	2.00E-02		
		U-233 (slow lung absorption)	4.00E+01	6.00E-03		
1.00E+01	1.00E-03	U-234				
		U-234 (fast lung absorption)	4.00E+01	9.00E-02		
		U-234 (medium lung absorption)	4.00E+01	2.00E-02		
		U-234 (slow lung absorption)	4.00E+01	6.00E-03		
Unlimited	Unlimited	U-235				
		U-235 (all lung absorption types)	Unlimited	Unlimited		
		U-236 (fast lung absorption)	Unlimited	Unlimited		
		U-236 (medium lung absorption)	4.00E+01	2.00E-02		
		U-236 (slow lung absorption)	4.00E+01	6.00E-03		
Unlimited	Unlimited	U-238				
		U-238 (all lung absorption types)	Unlimited	Unlimited		
3.00E-01	3.00E-01	V-48	4.00E-01	4.00E-01	1.33E+00	1.33E+00
4.00E+01	4.00E+01	V-49	4.00E+01	4.00E+01	1.00E+00	1.00E+00
1.00E+00	1.00E+00	W-178	9.00E+00	5.00E+00	9.00E+00	5.00E+00
3.00E+01	3.00E+01	W-181	3.00E+01	3.00E+01	1.00E+00	1.00E+00
4.00E+01	9.00E-01	W-185	4.00E+01	8.00E-01	1.00E+00	8.89E-01
2.00E+00	5.00E-01	W-187	2.00E+00	6.00E-01	1.00E+00	1.20E+00
2.00E-01	2.00E-01	W-188	4.00E-01	3.00E-01	2.00E+00	1.50E+00
		Xe-122	4.00E-01	4.00E-01		
		Xe-123	2.00E+00	7.00E-01		
		Xe-127	4.00E+00	2.00E+00		

Comparison of SS6 A1/A2 Values with TS-R-1 Values						
Values from SS6 1985 Edition (as amended 1990)		Radionuclide	Values from TS-R-1		Ratio of TS-R-1 Value to SS6 Value	
A ₁ (TBq)	A ₂ (TBq)		A ₁ (TBq)	A ₂ (TBq)	A ₁	A ₂
		Xe-131m	4.00E+01	4.00E+01		
		Xe-133	2.00E+01	1.00E+01		
		Xe-135	4.00E+00	2.00E+00		
2.00E+00	2.00E+00	Y-87	1.00E+00	1.00E+00	5.00E-01	5.00E-01
4.00E-01	4.00E-01	Y-88	4.00E-01	4.00E-01	1.00E+00	1.00E+00
2.00E-01	2.00E-01	Y-90	3.00E-01	3.00E-01	1.50E+00	1.50E+00
3.00E-01	3.00E-01	Y-91	6.00E-01	6.00E-01	2.00E+00	2.00E+00
2.00E+00	2.00E+00	Y-91m	2.00E+00	2.00E+00	1.00E+00	1.00E+00
2.00E-01	2.00E-01	Y-92	2.00E-01	2.00E-01	1.00E+00	1.00E+00
2.00E-01	2.00E-01	Y-93	3.00E-01	3.00E-01	1.50E+00	1.50E+00
3.00E+00	3.00E+00	Yb-169	4.00E+00	1.00E+00	1.33E+00	3.33E-01
3.00E+01	9.00E-01	Yb-175	3.00E+01	9.00E-01	1.00E+00	1.00E+00
2.00E+00	2.00E+00	Zn-65	2.00E+00	2.00E+00	1.00E+00	1.00E+00
4.00E+00	5.00E-01	Zn-69	3.00E+00	6.00E-01	7.50E-01	1.20E+00
2.00E+00	5.00E-01	Zn-69m	3.00E+00	6.00E-01	1.50E+00	1.20E+00
3.00E+00	3.00E+00	Zr-88	3.00E+00	3.00E+00	1.00E+00	1.00E+00
4.00E+01	2.00E-01	Zr-93	Unlimited	Unlimited	∞	∞
1.00E+00	9.00E-01	Zr-95	2.00E+00	8.00E-01	2.00E+00	8.89E-01
3.00E-01	3.00E-01	Zr-97	4.00E-01	4.00E-01	1.33E+00	1.33E+00

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