

IAEA Transport Regulations — What Has Changed in the Last Two Decades

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Abstract

The International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Materials (hereinafter referred as the Regulations) were first published in 1961 and then were revised roughly every decade through the 1990s. After publication of the 1996 edition, the Regulations were reviewed biennially and revised every two to four years till 2012. Those six editions (1996, 2000, 2003, 2005, 2009, and 2012) are regarded as the 1996 editions series without the need for new transitional arrangements, as impacts from the changes on package design or transport operations were considered relatively minor. Continuous deliberation for improvement during that period resulted in the following types of changes incorporated in those editions:

- Clarification or change of definitions (modification of requirements; “quality assurance” replaced by “management system”)
- Update of the General Provisions (Section III) and restructuring of classification for material and packages (Section IV)
- Incorporation of requirements for excepted packages containing uranium hexafluoride (UF₆)
- Enhancement of consistency of transport modal regulations (e.g., definition, specification)
- Reconstruction of provisions for the fissile excepted material or packages.

In June 2018, the 2018 edition of the Regulations was published as the IAEA Safety Standards Series No. SSR-6 (Rev. 1), which incorporates some notable changes such as the following:

- Addition of emergency response to objectives of the Regulations
- Change in terminology (dose rate instead of radiation level, marking versus mark, etc.)
- Introduction of concept of shipment after storage
- Introduction of SCO-III requirements (shipment of large objects), including definition
- Deletion of leaching test requirement for LSA-III material
- Consideration of ageing mechanisms during package design
- Inclusion of plug in assessment of individual isolation packages for those containing UF₆.

The set of changes was considered worth classifying the 2018 edition as the first of a new family of editions of the Regulations separate from the 1996 editions family. Consequently, the transitional arrangements for the 1973 edition expired, while the ones for the 1996 editions family are specified as in effect.

This paper summarizes changes incorporated in each edition of the Regulations after the 1996 edition till the 2018 edition to maintain an audit trail of changes made over the two recent decades.

Introduction

The Statute of the International Atomic Energy Agency (IAEA, or “the Agency”) authorizes the Agency to establish safety standards to protect health and minimize danger to life and property. For radioactive material transport, the IAEA establishes the Regulations for the Safe Transport of Radioactive Material (hereinafter referred as the Regulations) [1], and the Transport Safety Standards Committee (TRANSSC)¹ is responsible for review and revision of the Regulations. Every revision of the Regulation is incorporated into the Recommendations on the Transport of Dangerous Goods—Model Regulations (known as the United Nations Orange Book, or UNOB) and then is adopted as mandatory international or regional transport modal regulations for TRANSSC Member States.

First published in 1961, the Regulations were revised in 1964, 1967, 1973, 1985 and 1996. Since 2000, to follow the recommendations from the Agency and thereby shorten the revision intervals as well as enhance harmonization among international transport regulations, TRANSSC has used a biennial review/revision process, which had already been adopted by international transport modal organizations after the publication of the 1996 edition of the Regulations. The first two biennial reviews/revisions caused confusion because of simultaneous processing of different editions, conflicts with the Agency’s document publication process, the heavy burden on the TRANSSC Member States and the Secretariat, and the adverse effect on the stability of the Regulations. The TRANSSC then moved to a more flexible process, to “review biennially, and revise if necessitated” with the criteria for initiating the revision process based on whether the “set of proposed changes is sufficiently important to safety to necessitate urgent publication of a new edition of the Regulations.” Established by TRANSSC 11 (September 2005) and TRANSSC 12 (February/March 2006), the criteria were based upon six principles: (i) optimization, (ii) efficiency/practicability and regulation stability, (iii) compliance with dose limits, (iv) socioeconomic considerations, (v) harmonization, and (vi) clarification. The criteria were supported by 10 main questions and 10 subsidiary questions.

In 2010, the IAEA document publication process was improved as the “Strategies and Processes for the Establishment of IAEA Safety Standards” (SPESS), which specified who does what and how in each step toward publication of documents, including interventions from the TRANSSC and the Member States. Since then, the process for revision of the Regulations and associated supporting documents, such as the Advisory Material for the IAEA Regulations for the Safe Transport of

¹ It was called the Transport Safety Standards Advisory Committee (TRANSSAC) from January 1996 to December 2000, and before then it was the Standing Advisory Group on the Safe Transport of Radioactive Material (SAGSTRAM).

Radioactive Material (hereinafter referred as the Advisory) [2], strictly follows the SPESS steps. The following editions of the Regulations have been published since 2000. We identify each edition herein by year of publication.

- IAEA Safety Standards Series, Requirements No. TS-R-1 (ST-1, Revised), Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised), June 2000
- IAEA Safety Standards Series, Safety Requirements No. TS-R-1, Regulations for the Safe Transport of Radioactive Material, 1996 Edition (As Amended, 2003), July 2004
- IAEA Safety Standards, Safety Requirements No. TS-R-1, Regulations for the Safe Transport of Radioactive Material, 2005 Edition, August 2005
- IAEA Safety Standards, Safety Requirements No. TS-R-1, Regulations for the Safe Transport of Radioactive Material, 2009 Edition, May 2009
- IAEA Safety Standards, Specific Safety Requirements No. SSR-6, Regulations for the Safe Transport of Radioactive Material, 2012 Edition, October 2012
- IAEA Safety Standards, Specific Safety Requirements No. SSR-6 (Rev. 1), Regulations for the Safe Transport of Radioactive Material, 2018 Edition, June 2018

Major changes incorporated into each edition of the Regulations are described in the sections below.

Changes in the 2000 edition of the Regulations

When the stock of the English version of the 1996 edition was exhausted, TRANSAC V approved the publishing of the 2000 edition. This edition incorporated 18 errata items that had been identified and were listed and attached to the publication as “Errata for the IAEA *Regulations for the Safe Transport of Radioactive Material*, Safety Standards Series No. ST-1, 1996 Edition.” Only the following substantial changes were made to the test pressures for packaging intended to contain uranium hexafluoride (UF₆), to be consistent with ISO 7195 [3]: 1.4 MPa to 1.38 MPa and 2.8 MPa to 2.76 MPa in paras 632(b) and 718.

Changes in the 2003 Edition of the Regulations

The 2000–2001 revision process was the first biennial cycle to revise the Regulations. Change proposals from the TRANSSC Member States were classified as Major Change, Change of Detail, Minor Change, and Identified Problem. The following 12 Major Changes were incorporated in the 2003 edition. These changes were mostly for clarification; thus, there was no new transitional arrangement, per item (12).

- (1) Paragraph 107(e): Natural material or ores containing naturally occurring radionuclides that had been processed only for purposes other than for extraction of the radionuclides were also exempted from the scope of the Regulations.
- (2) Paragraph 313(new): Report of non-compliance with limits on radiation level or contamination was specified.
- (3) Paragraphs 314, 316, and 317 (new): Requirements for training were added to be consistent with

training items in the UNOB.

- (4) Table I: A_1 value for Cf-252 was revised based on International Commission on Radiological Protection ICRP Pub. 74.
- (5) Para. 514: An overpack was omitted from the exceptions of internal surface decontamination to avoid contamination transfer to the surfaces of packages contained.
- (6) Paragraphs 517(b)(i), (ii), and (iii): Marking exceptions for consumer products were extended.
- (7) Paragraph 549(k): For consignments of multiple packages in an overpack, freight container, or other conveyance, information on each package should be included in the transport documents.
- (8) Paragraph 619: Test pressure for packages transported by air was modified from “ambient-pressure reduction to 5 kPa” to “the maximum normal operating pressure (MNOP) plus 95 kPa” for clarification.
- (9) Paragraph 648(a): Acceptance criteria after additional tests for Type A package designed to contain liquid were specified so as to prevent “loss or dispersal of radioactive material” (“loss of shielding integrity” was deleted to be consistent with the criteria for the 9 m drop test).
- (10) Table XI: Form and location of insulated surfaces was modified for clarification.
- (11) Paragraph 672(a): Application of quantity limits for beryllium or deuterium in fissile exception provisions was clarified.
- (12) Paragraphs 815–818: No change in transitional arrangement.

Changes in the 2005 Edition of the Regulations

The 2002–2003 revision process was the second biennial cycle, which adopted minor changes in the process and classification of proposals. The most notable change in the 2005 edition was deletion of the “Schedules,” which was issued as a separate publication “IAEA Safety Standards, Safety Guide No. TS-G-1.6 Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material (2005 edition), May 2010”² (currently renumbered as SSG-33). Consequently, references to the “Schedules” in para. 110 and in Table 8 were deleted.

Other changes to be noted (other than those for clarification or for text improvement or editorial correction without substantial change in requirements) were as follows.

- (1) Paragraph order in Section III was rearranged to reflect the insertions on “non-compliance” and “training” in the 2003 edition. In para. 303, former group (a), regarding effective dose unlikely to exceed 1 mSv in a year, was deleted, because no action was required. Former paras 306 and 307 on segregation were moved to Section V to be integrated in para. 563.
- (2) In Table 1, to assist the calculation of basic radionuclide values, sets of parent radionuclides and progeny whose contribution was included in the parent’s values were listed in footnote (a), and footnote (b) was updated by deletion of the pairs Th-226–Ra-222, Th-226–Rn-218, Po-214–Np-

² Corresponding to the revisions of the Regulations, “IAEA Safety Standards, Safety Guide No. TS-G-1.6 (Rev.1) Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material (2009 edition), March 2014” and “IAEA Safety Standards, Specific Safety Guide No. SSG-33 Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material (2012 edition), February 2015” have also been published.

240m, and U-240–Np-240m.

- (3) For transport operations, precedence of the UN number, proper shipping name, categorization, labelling, and marking in accordance with the certificate of the country of origin (design) was clarified to avoid problems such as different assignments of UN numbers among countries in single international transport. In para. 550, the identification of consignor and consignee was added to the information included in the transport documents.
- (4) During the evaluation of the increase in radiation level after the tests for demonstrating ability to withstand normal conditions of transport, as prescribed in paras 624(c)(ii), 625(c), 627(c)(ii), 628(b)(ii), and 646(b), only the maximum value can be used. In Table 11, insolation data were further clarified with a slight change.
- (5) In fissile exception provision of para. 672(a), the smallest external dimension (10 cm) of packages was specified. In the criticality assessment for packages containing UF₆ in isolation, the maximum enrichment (5%) was specified in para. 677(b).
- (6) Specimens of special form radioactive material less than 500 g can be subjected to the Class 5 impact test in ISO 2919 as specified in para. 709(b)(ii).
- (7) As the due date (31 December, 2003) for part of the transitional arrangements had passed, arrangements for packaging intended to contain UF₆ and packaging whose design had been approved under the 1973 or 1985 edition of the Regulations were updated.
- (8) For shipment of packages containing fissile material by sea-going vessels, no multilateral approval was required (even if the sum of the criticality safety indexes exceeds 50), if requirements in Table 10 were met (para. 820(c)).
- (9) As prescribed in para. 833, the following information is to be additionally included in the certificate of approval of a package design, as applicable:
 - Description of the containment system
 - Description of the confinement system
 - For packages containing > 0.1 kg of UF₆, demonstration of compliance with para. 632.

TRANSSC intended to publish these changes as the “1996 Edition (As amended 2005)” to avoid new transitional arrangements, which had been agreed to be introduced when the Regulations were “revised” as a new edition, but the Commission of Safety Standards renamed it as the “2005 Edition.” To cope with this issue, in the 2009 and 2012 editions of the Regulations, a footnote to the title of Section VIII (Approval and Administrative Requirements) was placed to express that this edition belongs to the 1996 editions family (thus, no newly incorporated transitional arrangements).

Changes in the 2009 Edition of the Regulations

According to the criteria regarding whether or not a cycle included revision, the cycle initiated in 2007 was closed as a review-only cycle. However, pressures to publish a new edition to maintain timely input to the UNOB resulted in the urgent issuing of the 2009 edition, taking proposals accepted in the 2007 cycle and changes enhancing harmonization with the UNOB. To more closely match the UNOB, provisions to classify material, objects, and packages were compiled in Section V, as tabulated

in the table below, while also ensuring that the wording and style resembled that of the UNOB. Another important change was the incorporation of consideration of security in para. 109 with listing of references in Annex 1. Other changes were minor ones or were clarifications, such as

- (1) In para. 104, the objective of the Regulation was changed to establishing requirements from protecting persons, property, and environment.
- (2) Definition of fissile nuclides was added in para. 222.
- (3) Basic radionuclide values for Kr-79 were added to Table 2.
- (4) Fissile exception provisions were moved to para. 417 (formerly 672) with some clarifications.
- (5) Requirements for UN marking for packages and overpacks were tabulated as Table 10.

Change of Section IV Structure in 2009 Edition

2009 Edition		2005 Edition
Para(s) No(s).	Description	Para(s) No(s).
GENERAL PROVISIONS		
401	Assignment of UN number	—
Table 1	UN numbers, proper shipping names, etc.	Table 8
BASIC RADIONUCLIDE VALUES		
402-407	Determination of basic radionuclide values	401–406
Table 2	Basic radionuclide values	Table 1
Table 3	Basic radionuclide values for mixtures of unknown radionuclides	Table 2
CLASSIFICATION OF MATERIAL		
408	Classification of low specific activity (LSA) material	—
409	Requirements for LSA material	226
410	Activity limit by air	412
411	Radiation level and activity limits	411
412	Classification of surface-contaminated objects (SCOs)	—
413	Requirements for SCOs	241
414	Radiation level and activity limits	411
415	Classification of special form radioactive material	—
416	Classification of low dispersible radioactive material	—
417	Classification of packages containing fissile material, together with fissile exception provisions	672
418	Content limits for fissile packages	418
Table 4	Fissile mass limits	Table 12
419	Classification of UF ₆ packages	—
420	Content limits for UF ₆ packages	419
CLASSIFICATION OF PACKAGES		
421	Content limits for packages	407
422	Classification of excepted packages	408
Table 5	Activity limits for excepted packages	Table 3
423	Requirements for excepted package—Instruments or articles	517
424	Requirements for excepted package—Limited quantity	518
425	Requirements for excepted package—Empty packaging	520
426	Requirements for excepted Package—Articles manufactured from natural or depleted uranium or from natural thorium	409

427	Classification of Type A packages	—
428	Content limits for Type A packages	413
429	Mixture of radionuclides	414
430	Classification of Type B(U), B(M), and C packages	—
431	Content limits for Type B(U) packages	415
432	Content limits for Type B(M) packages	415
433	Content limits for Type B(U) and B(M) packages by air	416
434	Content limits for Type C packages	417
SPECIAL ARRANGEMENT		
435	Classification of special arrangements	—

Changes in the 2012 Edition of the Regulations

Issues carried over from the initiated 2007 cycle and additional ones from the 2009 cycle, which was initiated but closed as a review-only cycle, were subjected to intensive effort to reach consensus resolution through technical or consultancy meetings and working or corresponding groups. Many of the issues concerned fissile and criticality aspects that had been discussed among experts since publication of the 1996 edition and were finally concluded in the 2012 edition as a new framework of provisions for packaging and transporting fissile material. Within this framework, four options were prescribed:

- Non-fissile: Not defined as fissile material (para. 222, < 0.25 g/package)
- Fissile excepted: Excepted from UN Fissile classification and Criticality Safety Index (CSI) control (paras 417 and 570, and 802(a)(iii) when under para. 471(f) that requires competent authority approval)
- Fissile: Classified as UN fissile. CSI control with exception from competent authority approval of package design for fissile material (paras 674 and 675, Table 13)
- Fissile: Classified as UN fissile. CSI control with competent authority approval of package design (paras 673, 676–686, 802(a)(iv))

Details for the application of these provisions are given in IAEA-TECDOC-1768 [4]. Transitional arrangements for fissile excepted material were provided in para. 822.

Other notable changes were as follows:

- (1) Transport of a person who accidentally ingested radioactive material, or contaminated, was exempted from the scope of the Regulations (para. 107(d)). Natural material (such as ores) containing naturally occurring radionuclides, which may have been processed, was also exempted from the scope (para. 107(f)).
- (2) “Management system” was defined in para. 228 to replace “quality assurance.”
- (3) UN 3507 “URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, less than 0.1 kg per package, non-fissile or fissile-excepted” was added to Table 1 and paras 419 and 422, and requirements were specified in para. 425.
- (4) Alternative activity limit for consumer products under relevant competent authority approval was introduced (paras 403(b), 802(f), 817, 818, 832(c) and 839).

- (5) Confirmation of radioactive contents before each shipment to be in compliance with package design was specified in para. 502.
- (6) For transport documents, period of retention (para. 555) and availability by carriers (paras 584–588) were specified.

Changes in the 2018 Edition of the Regulations

As in the process to prepare the 2012 edition, after issues were collected from the initiated 2013 cycle, resolved issues were proposed in the initiated 2015 cycle to be moved to a revision cycle. As this edition contains some notable changes, such as introduction of new concepts for shipment, changes that may impact the material or package design, it was concluded as a new edition (separate from the 1996 editions family), requiring a new set of transitional arrangements for the first time in 22 years. Major changes that were incorporated in the 2018 edition are summarized below.

- (1) Arrangements for planning and preparing for emergency response were included in the objectives of the Regulations (para. 104), as they provide a further layer of protection for transport safety. In para. 304, “emergency” was defined as a nuclear or radiological emergency during the transport of radioactive material, and consignors and carriers were required to establish arrangements for emergency. Application of a graded approach to arrangements was specified in para. 305.
- (2) In response to the recommendations from the TRANSSC/WASSC³ Joint Working Group, the concept of the dual purpose cask was incorporated as follows [5]:
 - “Shipment after storage” was added to the scope of the Regulations (para. 106).
 - Compliance with the Regulations during long-term storage was required to ensure transportability for shipment after storage (para. 503(e)).
 - In the application for approval of package design intended to be used for shipment after storage, justification of consideration of ageing (para 809 (f)) and a gap analysis program (para. 809(k)) were required.
- (3) Requirements for the shipment of large components provided in Appendix VII of the 2012 edition of the Advisory for a case under special arrangement were incorporated in the Regulations as the shipment of SCO-III to avoid use of special arrangements. According to the basic concept for such shipment, the same level of safety can be achieved if the outer shell of the component is considered as packaging [6].
 - Requirements for the object (SCO-III) were specified in para. 413(c).
 - Requirements and controls for the transport of SCO-III were specified in para. 520(e).
 - Allowance for SCO-III shipment when the load limit in Table 6 is exceeded was included. In such cases, the same level of safety as a Type A package shipment must be demonstrated.
 - Multilateral approval was required for SCO-III shipment in para. 825(e), and application for approval of SCO-III shipment was specified in para. 827A.

³ WASSC: Waste Safety Standards Committee

- (4) Based on investigative work conducted in Europe since the early 2000s, no relation between results of leaching tests for LSA-III material and activity release from the material in accidents has been demonstrated [7]. Therefore, the requirements related to leaching tests for LSA-III material were deleted from paras 409(c), 610, and 701.
- (5) “Radiation level” (former para. 233) was replaced by “dose rate” (para. 220A).
- (6) Basic radionuclide values for seven radionuclides (Ba-135m, Ge-69, Ir-193m, Ni-57, Sr-83, Tb-149, and Tb-161) were added to Table 2. In footnote (a), parent/progeny pairs Ar-42/K-42 and Te-118/Sb-118 were deleted, and in footnote (b), treatment of the contribution of daughter nuclides to A_1 and/or A_2 values of the parent nuclides was clarified to be included. Parent nuclides for natural Th and natural U were clarified as Th-232 and U-238, respectively.
- (7) Only a consignor can determine the Transport Index by direct measurement (para. 524).
- (8) Marks on a consignment not related to UN number and proper shipping name were to be deleted or covered (para. 536A). In Figures 2 through 5, the line width of the black diamond on labels was specified to be 2 mm.
- (9) The dose rate limits for conveyance were made applicable only to vehicles. No limit was applied to sea-going vessels or aircrafts (para. 566).
- (10) The design of the package was required to consider aging mechanisms (para. 613A). A graded approach applicable to this consideration will be given in the next edition of the Advisory.
- (11) No physical contact between the plug with any other component of a UF₆ cylinder following a series of prescribed tests was allowed (para. 680(b)).
- (12) A new set of transitional arrangements was introduced.
 - Footnote to Section VIII title was deleted.
 - Transitional arrangements were provided for packaging designed under the 1985, 1996, and subsequent editions till the 2012 edition of the Regulations (paras 819–823). The transitional arrangements for the 1973 edition were made obsolete.
 - In the identification mark that is assigned by the competent authority for the approval certificate, “-96” was deleted (paras 832 and 833).

Finally, the most beneficial change made in this edition may be adoption of a new paragraph numbering system to maintain the same paragraph numbers in future editions of the Regulations.

Future Work

Although many issues in the Regulations have been resolved by the efforts of the TRANSSC Member States and the Secretariat, a lot still remains, such as regarding freight containers, criticality, test conditions, further harmonization with the UNOB, clarification, and user friendliness. These are expected to be resolved through the activities of the TRANSSC Technical Expert Groups established in 2018.

Conclusions

After the publication of the 1996 edition of the Regulations more than 22 years ago, a biennial

review/revision process was adopted for the publication of subsequent editions of the Regulations. Currently the process is working quite well. Corresponding to the progress of improvement of the process, changes incorporated in each revised edition of the Regulations have been upgraded from a level of clarification to reorganization of sections, harmonization with the UNOB, a new framework for fissile provisions, and introduction of new types of shipment to address the needs of users of the Regulations. The 23 years of collaboration has established a sound rule-making process built on a strong technical foundation, while maintaining the stability of the Regulations.

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