

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

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Abstract

The IAEA Regulations for the Safe Transport of Radioactive Materials were first published in 1961, and since then revised roughly decennially. After the publication of the 1996 Edition, the Regulations had been reviewed biennially and revised in 2 to 4 years intervals, i.e., in 2000, 2003, 2005, 2009 and 2012. During this period, continuous deliberation for improvement was made to result following typical changes to be incorporated in these Editions:

- Clarification or change of definitions (modification of requirements, quality assurance → management system);
- Update of the General Provisions (Section III);
- Incorporation of requirements for excepted package containing uranium hexafluoride (UN 3507);
- Further enhancement of consistency to the transport modal regulations (e.g., the definition of freight container);
- Reconstruction of provisions for the fissile excepted material/packages.

Above 6 Editions are regarded in the same 1996 Edition family without a need for transitional arrangements, since impacts from these changes to package design or transport operation were considered relatively small.

In June 2018, the 2018 Edition of the Regulations was published as the IAEA Safety Standards Series No. SSR-6 (Revision 1), that incorporates some remarkable changes such as:

- Introduction of requirements for shipment of SCO-III (large object) including its definition;
- Change in terminology (radiation level → dose rate, marking vs mark, etc.);
- Addition of emergency response to the objective of the Regulations;
- Introduction of a concept of shipment after storage;
- Consideration of ageing mechanism in package design;
- Deletion of the leaching test requirement for LSA-III material;
- Inclusion of the plug in the assessment of an individual package in isolation for the package containing uranium hexafluoride.

A set of changes is considered worth to classify the 2018 Edition as a new edition of the Regulations separate from the 1996 Edition family, and consequently, the transitional arrangements for the 1973 Edition are expired, and the ones for the 1996 Edition family are specified.

This paper summarizes changes incorporated in each Editions of the Regulations after the 1996 Edition up to the 2018 Edition to maintain an audit trail of changes over recent 22 years.

Introduction

The Statute of the International Atomic Energy Agency (IAEA) authorizes the Agency to establish safety standards to protect health and minimize danger to life and property. For radioactive material transport, 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 to the Recommendations on the Transport of Dangerous Goods – Model Regulations (known as UN Orange Book, UNOB), then adopted to the international or regional transport modal regulations to be mandatory in the Member States (MS) related.

The Regulations were first published in 1961, then revised in 1964, 1967, 1973, 1985 and 1996 in the 20th century with roughly 10 years intervals. After the publication of the 1996 Edition of the Regulations, to follow the recommendations from the Agency to shorten the revision intervals and to enhance harmonization among the international transport regulations, since 2000 TRANSSC adopted a biennial review/revision process, which had already been adopted by the international transport modal organizations. Conduction of the first two biennial processed found that it caused confusions due to running of multiple process for different editions, conflicts with the Agency’s document publication process, heavy burden to the MS and the Secretariat, and adverse effect on the stability of the Regulations. Then TRANSSC moved to more flexible process as “review biennially, and revise if necessitate” with criteria to initiate revision process as “a set of proposed changes is sufficiently important to safety to necessitate urgent publication of a new edition of the Regulations?” The criteria were established in TRANSSC 11 (September 2005) and TRANSSC 12 (February/March 2006) based upon 6 principles, i.e., (i) optimization, (ii) efficiency/practicability/regulation stability, (iii) compliance with dose limits, (iv) socio-economic considerations, (v) harmonization and (vi) clarification, and supported by 10 major questions and 10 subsidiary questions.

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

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

Radioactive Material (hereinafter referred as the Advisory) [2], strictly follow the SPESS steps.

Following editions of the Regulations have been published since 2000. In this paper, each edition is identified by the 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 (overridden by the corrected version in September 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.

In the sections below, major changes incorporated to the each edition of the Regulations are described.

Changes in the 2000 Edition of the Regulations

TRANSSAC V approved to publish the 2000 Edition, incorporating the errata that had been identified, since stocks for the English edition of the 1996 Edition exhausted. 18 errata items 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 substantial changes were on the test pressures for packaging intended to contain UF₆ to be consistent to ISO 7195 as 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 MS were classified as Major Change, Change of Detail, Minor Change and Identified Problem, and following 12 Major Changes were incorporated to the 2013 Edition. These changes were more or less of clarification nature, thus no new transitional arrangement was employed (item (12)).

- (1) Paragraph 107(e): Natural material or ores containing naturally occurring radionuclides that had been processed only for purpose other than for extraction of the radionuclides was 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 UNOB.

- (4) TABLE I: A₁ value for Cf-252 was revised based on ICRP Pub. 74.
- (5) Para. 514: An overpack was omitted from the exception 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 over pack, freight container or conveyance, information of each package should be included in the transport documents.
- (8) Paragraph 619: Test pressure for packages transported by air is 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 criterion after additional tests for Type A package designed to contain liquid were specified as to prevent “loss or dispersal of radioactive material” (“loss of shielding integrity” was deleted to be consistent with the criteria for 9 m drop test).
- (10) TABLE XI: Form and location of surfaces insulated was modified for clarification.
- (11) Paragraph 672(a): Application of quantity limits on beryllium or deuterium in fissile exception provisions was clarified.
- (12) Paragraphs 815 – 818: No change on 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 the classification of proposals. The most remarkable change in the 2005 Edition was deletion of 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 schedules in para. 110 and TABLE 8 were deleted. Other changes
Other changes to be noted, other than changes for clarification, text improvement without substantial change in requirements or editorial correction, can be listed as follows.

- (1) Paragraph order in Section III was rearranged to reflect the areas introduced in the 2003 Edition, i.e., “non-compliance” and “training”. In para. 303, former group (a) (effective dose is most unlikely to exceed 1 mSv in a year) was deleted, since no action was required. Former paras 306 and 307 on segregation were moved to Section V to be integrated.
- (2) To assist calculation of the basic radionuclide values, sets of parent radionuclides and progeny whose contribution was included to the parent’s values were listed in footnote (a) of TABLE 1. Footnote (b) was updated with deletion of pairs of Th-226 – Ra-222, Rn-218, Po-214 and U-240

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” are also published.

– 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 of design was clarified to avoid difference in assignment of the UN number, etc. among countries in single international transport. In para. 550 the identification of consignor and consignee was added to information included in the transport documents.
- (4) In the evaluation of increase in radiation level after the tests for demonstrating ability to withstand normal condition 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 focused. 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) The due date (31 December 2003) for part of special arrangements had passed, arrangements for packagings intended to contain UF₆ and packagings whose design had approved under the 1973 Edition or the 1985 Edition of the Regulations were updated.
- (8) For shipment of packages containing fissile material by sea-going vessels, no multilateral approval is required even the sum of the criticality safety indexes exceeds 50 if requirements in TABLE 10 are met (para. 820(c)).
- (9) As prescribed in para. 833, following information is to be additionally included in the certificate of approval of a package design, as applicable:
 - A description of the containment system.
 - A description of the confinement system
 - For packages containing more than 0.1 kg of UF₆, demonstration of compliance with para. 632.

TRANSSC intended to publish as “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 (CSS) renamed as “2005 Edition”. To cope with this issue, a footnote to the title of Section VIII (Approval and Administrative Requirements) was placed to express that this edition belongs to the family of the 1996 Edition (thus, no new transitional arrangements incorporated.) in the 2009 and 2012 Editions of the Regulations.

Changes in the 2009 Edition of the Regulations

Adopting the criteria whether moving to a revision cycle, the cycle initiated in 2007 was closed as review only cycle. However, pressures to publish a new edition to maintain timely input to UNOB resulted urgent issue of the 2009 Edition, taking proposals accepted in the 2007 cycle and enhancing

harmonization to UNOB. To be resemble to UNOB, provisions to classify material, objects and packages were gathered in Section V as tabulated in Table 1 with taking text and style used in UNOB. Another memorable change was the incorporation of consideration to security in para. 109 with further references listed in Annex 1. Other changes were minor ones or of clarification nature, 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 add in para. 222.
- (3) Basic radionuclide values for Kr-79 were added to TABLE 2.
- (4) Fissile exception provisions were moved to para. 417 (former 672) with some clarifications.
- (5) Requirements for UN marking for packages and overpacks were tabulated as TABLE 10.

Changes in the 2012 Edition of the Regulations

Issues carried over from the 2007 initiated cycle and additional issues collected in the 2009 initiated cycle, which was closed as review only cycle, were subjected to intensive effort to reach consensus resolution through Technical Meetings, Consultancy Meetings, Working Groups and Corresponding Groups. Large part of issues was on fissile/criticality aspect that had been discussed among criticality experts since the 1996 Edition publication, finally concluded in the 2012 Edition as a new framework of provisions for fissile material and packages. In this framework four options for transporting material containing fissile nuclides were prescribed as:

- Non-fissile: Not defined as fissile material (para. 222, < 0.25 g/package).
- Fissile excepted: Excepted from UN Fissile classification and 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 provision are given in IAEA-TECDOC-1768 [3]. Transitional arrangements for fissile excepted material was provided in para. 822.

Other changes to be noted can be listed as follows:

- (1) Transport of a person who accidentally took radioactive material in, or contaminated, or natural material and ores containing naturally occurring radionuclides which may have been processed are exempted from the scope of the Regulations (paras 107(d) and (f)).
- (2) “Management system” was defined in para. 228 to replace “quality assurance”.
- (3) UN 3507 “URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, loss than 0.1 kg per package, non-fissile or fissile-excepted” was added to TABLE 1, paras 419, 422, and requirements were specified in para. 425.

Table 1 Change of Section IV Structure in the 2009 Edition

2009 Edition		2005 Edition
Para No.	Description	Para No.
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 unknown radionuclides of mixtures	TABLE 2
CLASSIFICATION OF MATERIAL		
408	Classification to LSA material	—
409	Requirements for LSA material	226
410	Activity limit by air	412
411	Radiation level and activity limits	411
412	Classification to SCO	—
413	Requirements for SCO	241
414	Radiation level and activity limits	411
415	Classification to special form radioactive material	—
416	Classification to low dispersible radioactive material	—
417	Classification to 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 to UF ₆ package	—
420	Content limits for UF ₆ packages	419
CLASSIFICATION OF PACKAGES		
421	Content limits for packages	407
422	Classification to 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 U, Depleted U or Natural Th.	409
427	Classification to Type A packages	—
428	Content limits for Type A packages	413
429	Mixture of radionuclides	414
430	Classification to 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), B(M) packages by air	416
434	Content limits for Type C packages	417
SPECIAL ARRANGEMENT		
435	Classification to special arrangement	—

- (4) An 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) Before each shipment, confirmation of the radioactive contents to be comply with the package design was specified in para. 502.
- (6) For transport documents, the period of retention (para. 555) and availability by carriers (paras 584 – 588) were specified.

Changes in the 2018 Edition of the Regulations

As same as the process to prepare the 2012 Edition, issues were collected in the 2013 initiated cycle and resolved issues were proposed in the 2015 initiated cycle to move to a revision cycle. As this edition contains some remarkable changes, such as introduction of new concepts of shipment, changes which may have impact to the material or package design, it was concluded as a new edition to be separated from the 1996 edition family to necessitate a new set of transitional arrangements for the first time in recent 22 years. Major changes incorporated to the 2018 Edition are summarized below.

- (1) To the objectives of the Regulations in para. 104, arrangements for planning and preparing emergency response are included as they provide further protection layer to the transport safety. In para. 304 “emergency” is defined as a nuclear or radiological emergency during the transport of radioactive material, and consignors and carriers are required to establish arrangements for emergency. Application of graded approach to arrangements is specified in para. 305.
- (2) In response to the recommendations from the TRANSSC/WASSC³ Joint Working Group, a concept of the Dual Purpose Cask (DPC) is incorporated in a manner that:
 - “Shipment after storage” is added to the scope of the Regulations (para. 106).
 - Compliance to the Regulations during long-term storage is required to ensure transportability in the shipment after storage (para. 503(e)).
 - In the application for approval of package design intended to be used for the shipment after storage, a justification of consideration to ageing (para 809 (f)) and a gap analysis program (para. 809(k)) are required.
- (3) Requirements for the shipment of large components provided in the Appendix VII of the 2012 Edition of Advisory for the case under special arrangement are incorporated to the Regulation as the shipment of SCO-III to avoid use of special arrangement. A basic concept of this shipment is the same level of safety can be achieved if the outer shell of the component is considered as a packaging.
 - Requirement for the object (SCO-III) are specified in para. 413(c).
 - Requirements and controls for the transport of SCO-III are specified in para. 520(e).
 - Allowance for SCO-III shipment when the loading limit in TABLE 6 exceeded. In such case a same level of safety as a Type A package shipment should be demonstrated.
 - Multilateral approval is required for the SCO-III shipment in para. 825(e), and application for approval of SCO-III shipment is specified in para. 827A.
- (4) Based on the investigation work conducted in Europe since early 2000s, no relation between the leaching test for LSA-III material and the activity release from the material in accidents has been demonstrated. Therefore, the leaching test related requirements for LSA-III material are deleted in paras 409(c), 610 and 701.
- (5) “Dose rate” is defined in para. 220A to replace “radiation level”.
- (6) Basic radionuclide values for 7 radionuclides, i.e., Ba-135m, Ge-69, Ir-193m, Ni-57, Sr-83, Tb-

³ WASSC: Waste Safety Standards Committee

149, Tb-161 are added to TABLE 2. In footnote (a), parent/progeny pairs Ar-42/K-42 and Te-118/Sb-118 are deleted. In footnote (b), treatment of contribution of daughter nuclides to A₁ and/or A₂ values of their parent nuclide is clarified to be included. Parent nuclides for Th-natural and U-natural are clarified as Th-232 and U-238, respectively.

- (7) Only a consignor can determine the Transport Index (TI) by direct measurement (para. 524).
- (8) Marks on consignment not related to UN number and proper shipping name are to be deleted or covered (para. 536A). In FIG.2 – FIG 5 the line width of the black diamond on labels is specified as 2 mm.
- (9) The dose rate limits around conveyance are only applicable to vehicles. No limit is applied to vessels or airplanes (para. 566).
- (10) The design of the package is required to consider aging mechanisms (para. 613A). Graded approach applicable to this consideration will be given in the next edition of the Advisory.
- (11) No physical contact between the plug, as well as the valve, and any other component of UF₆ cylinder following a series of tests prescribed is allowed in para. 680(b).
- (12) A new set of transitional arrangements are introduced.
 - Footnote to the Section VIII title is deleted.
 - Requirements and controls for the transport of SCO-III are specified in para. 520(e).
 - Transitional arrangements are provided for packagings designed under the 1985 Edition, 1996 Edition and subsequent Editions of the Transport Regulations up to the 2012 Edition in paras 819 – 823. The transitional arrangements for the 1973 Edition are obsolete.
 - In the identification mark assigned by Competent Authority for approval certificate, “-96” is deleted (paras 832, 833).

Finally, the most beneficial change 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 Works

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

Conclusions

After the publication of the 1996 Edition of the Regulation 22 years ago, biennially review/revision process was adopted to the publication of the new editions of the Regulations. Currently the process is working quite well. Corresponding to the progress of improvement of the process, changes incorporated to each revised edition of the regulation have been upgraded from a level of clarification to reorganization of sections, harmonization with UNOB, new framework for fissile provisions and introduction of new types of shipment to catch up needs from the users of the Regulations. 22 years of

elaboration has established a sound manner of rule-making process on a sound technical basis, while maintaining the stability of the Regulations.

Acknowledgement

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References

- [1] International Atomic Energy Agency, Specific Safety Requirements No. SSR-6 (Rev.1) “Regulations for the Safe Transport of Radioactive Material, 2018 Edition”, IAEA, Vienna (2018).
- [2] International Atomic Energy Agency, Specific Safety Guide No. SSG-26 “Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition)”, IAEA, Vienna (2014).
- [3] International Atomic Energy Agency, IAEA-TECDOC-1768 “Application of the Revised Provisions for Transport of Fissile Material in the IAEA Regulations for the Safe Transport of Radioactive Material 2012 Edition”, IAEA, Vienna (2015).