The 1996 Revision of the International Atomic Energy Agency's Regulations for the Safe Transport of Radioactive Material

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INTRODUCTION

To keep the IAEA's Transport Regulations (IAEAa) abreast of recent scientific and technological developments, a major review of the Regulations takes place at intervals of approximately 10 years. This time interval allows international organizations and Member States to schedule rule-making activities regarding the revised Regulations while maintaining an acceptable level of regulatory stability. In continuation of this process, the 1985 edition of the Regulations is being followed by a 10- year review process which will lead to the next edition of the Regulations in 1996.

A large group of experts, known as the Revision Panel, instructs the Secretariat on the drafting of the revised Regulations and their supporting documents (IAEAb, IAEAc). Four meetings of the Panel have been held for the revision of the 1985 (As Amended 1990) version of the Regulations. Drafts of the revised regulations were circulated to all Member States for comment following the second and third Revision Panels and formal comments on the drafts were considered by the subsequent Revision Panel meetings. Additionally, a third draft was prepared just prior to the fourth Revision Panel to assist in evaluation of all of the recommendations made by Technical Committees and Consultants Services Meetings held after the third Revision Panel. The fourth and final draft was prepared based on the results of the fourth and final Revision Panel.

This paper presents information on the most significant revisions which have been incorporated into the final draft of the 1996 Regulations.

AMENDMENTS RELATED TO THE INTERNATIONAL BASIC SAFETY STANDARDS

One of the major topics considered in the Revision Process is the incorporation of the new Basic Safety Standards (BSS) for radiation protection (IAEAd). The BSS have been revised to reflect the consensus surrounding the latest recommendations of the International

Commission on Radiological Protection (ICRP 1991) and the Regulations call upon the BSS as a general provision for radiological protection. Consequently, this revision of the transport regulations needed to take into account the revised BSS requirements.

General Provisions

The Revision Panel has accepted new text for the General Provisions on Radiation Protection. Some important changes have been recommended, including the need to establish Radiation Protection Programmes (RPPs) for the transport of radioactive material. RPPs emphasize the importance of the General Provisions which provide the justification for maintaining the current regulatory limits for radiation levels around packages and conveyances. It is important to recall that these limits have led to low individual and collective doses to both workers and members of the public.

Dose assessment programs for occupational exposures arising from transport operations will be prescribed on the basis of likely annual doses. For occupational exposures which are unlikely to exceed 1 mSv/y, no special actions such as special work patterns, detailed monitoring, nor individual record keeping are required. Workplace monitoring is required for exposures expected to be in the range of 1-6 mSv/y. Individual monitoring is required for exposures likely to exceed 6 mSv/y. To assist operators in estimating the exposure of their workforce, advice has been provided that correlates exposure with the number of packages handled and the radiation level at 1 m from the packages. It is believed to be unlikely that carriers handling less than 300 TI per year will exceed the 1 mSv threshold. This graded approach is an adaptation of the current Regulation which has proven to be practicable in transport applications. Workers engaged by consignors and consignees can be expected to be covered by radiation protection programs administered at the fixed-site. Carriage, on the other hand, is a transient operation for which the classification of work areas can be difficult to apply.

Exemption

The Regulations have always contained exemption criteria which defined materials subject to their requirements. The current Regulations define radioactive material as any material having a specific activity greater than 70 Bq/g. The BSS, however, use a radionuclide-specific approach which leads to derived exemption values spanning seven orders of magnitude, and straddling 70 Bq/g in the case of activity concentration. The BSS also present exemption values for total activity quantities (Bq).

Consultant groups have stressed the benefit of harmonization between the BSS and the Regulations. Nevertheless, adopting the values for exemption presented in the BSS is a major change to the Regulations. A Technical Committee in June 1994 considered the underlying scenarios and models used to derive the exemption levels for the BSS and concluded that they had not been demonstrated to be appropriate for transport purposes. The Committee recognized that the single exemption level of 70 Bq/g has no dose basis and that it is unlikely that this level satisfies the general dose criterion of 10 μSv in a year for exemption for all radionuclides. The Committee also recognized that the use of

different exemption levels in various practices may give rise to problems at interfaces and may cause legal and procedural complications.

The Agency convened a group of consultants to develop transport scenarios and assump tions to be used in the derivation of exemption values that are suitable for transport. A set of transport-specific scenarios were developed which reflected various exposure situations (exposure times, distances, source geometries, etc.). Based on these scenarios, both activity concentration and total activity values were calculated which would result in meeting the 10 μSv/a value. These transport derived values were comparable to the exemption values in the BSS and resulted in recommended activity concentrations ranging from 1 to 10^6 Bq/g. A Technical Committee further considered the issue in June 1995 and concluded that, given the difficulty in technically justifying the 70 Bq/g value and the similarity in results from the transport scenarios and the BSS scenarios, it was preferable to simply adopt the BSS derived exemption values. The fourth Revision Panel endorsed this approach and recommended that the Regulations include both activity concentration and total activity per consignment exemption values. For mixtures of radionuclides, the "ratio rule" must be applied so that sum of the activities (or activity concentrations) present for each radionuclide divided by the applicable exemption value is less than or equal to 1. Examples of the new exemption values are shown in Table 1.

Table 1: Exemption Values for Selected Radionuclides

Nuclide	Activity Concentration (Bq/g)	Activity per Consignment (Bq)	Nuclide	Activity Concentration (Bq/g)	Activity per Consignment (Bq)
Co-60	$1x10^1$	$1x10^5$	Ra-226	$1x10^1$	$1x10^4$
Sr-90	$1x10^2$	$1x10^4$	U-nat	$1x10^0$	$1x10^3$
Cs-137	$1x10^1$	$1x10^4$	Pu-239	$1x10^0$	$1x10^4$

Some Member States expressed concern about materials that are not now regulated (below 70 Bq/g) but which will be regulated under the revised approach. A late proposal was made to allow "conditional exemption" of material with an activity concentration up to 70 Bq/g if the Competent Authority is satisfied that exempting the material will not result in inappropriate doses. There was not sufficient time for the final Revision Panel to reach a decision on this issue, so comments were invited on the proposal and will be compiled by the Scientific Secretariat. If sufficient support exists for the concept, the Secretariat will hold a Consultants Service Meeting to consider the comments and more fully develop the approach. Any recommendations will be provided to the Transport Safety Series Advisory Committee (TRANSSAC, the senior advisory replacement for SAGSTRAM) in March 1996 for consideration.

A_1/A_2 Values and the Q System

The "Q System" is a dose-based set of models which is used to derive the A_1 and A_2 values in the Regulations. The A_1 and A_2 values are activity quantities, calculated for each radionuclide, that set the limits on contents for Type A packages and for specifying other activity limits. The fundamental assumptions in the Q System constrain the detriment to an individual in the event of serious damage to a single Type A package by restricting the dose to the order of 50 mSv. The impact of the BSS on the Q System is limited since the Q System falls in the domain of potential exposures. Potential exposures are not expected to be delivered with certainty, and can result from an accident or events of a probabilistic nature. Since potential exposures are not subject to the dose limits applying to normal exposures (20 mSv a^{-1}, in general), the reference dose of 50 mSv can continue to be used in the context of the Q System. However, a group of specialists have calculated revised A_1 and A_2 values based on complete spectral emissions from radionuclides and also taking into account new radiation weighting factors, new tissue weighting factors, and the latest metabolic models incorporated into the BSS. While there is an underlying desire to keep the Regulations as stable as possible, maintaining the scientific rigour of the Q System was felt to be an overriding consideration for ensuring that the regulations remain abreast of current thinking in radiological protection.

Low specific activity (LSA) material and surface contaminated objects (SCO)

Some problems have been identified with the current Regulations regarding both LSA material and SCO. These include:

- concerns about the underlying radiological model leading to uncertainty in the doses that might result from an accident;
- difficulty in applying constraining phrases such as that the radioactive material shall be 'distributed throughout a solid or a collection of solid objects';
- other practicable problems in assessing some of the criteria including non-fixed contamination.

During the revision process a number of groups have met to discuss these issues leading to proposals to change package content limits, altering material specifications, and combining package categories. These groups also identified the need for an analogue to the Q System for these materials. This analogue is expected to provide a radiological basis for a comprehensive review of the LSA and SCO provisions. The Agency has initiated a Coordinated Research Program to facilitate Member States undertaking and sharing results of technical studies on the development of appropriate models. In considering these issues, the Revision Panel implemented the recommendation of SAGSTRAM to make a minimum number of changes until the analogue becomes available during the next revision cycle. In the meantime both regulators and operators will continue to work around the known problems.

OTHER KEY AMENDMENTS TO THE REGULATIONS

Type C Packages

Agreement was reached at the Revision Panel on requiring a more robustly designed package type, called a Type C package, for certain high-activity shipments transported by aircraft. Many of the design and performance requirements for Type C packages recommended in IAEA-TECDOC-702 (IAEA) have been adopted. Any package design for more than 3,000 A_2 for normal form material, or 3,000 A_1 (not to exceed 100,000 A_2) for special form material, must meet the Type C requirements. The performance requirements include:

- those applicable to Type B(U) packages and, if appropriate, packages for fissile materials;
- a puncture/tearing test consisting of a truncated cone-shaped probe which is either dropped 3 m onto the package or the package is dropped onto the probe, depending on the mass of the package specimen;
- an enhanced thermal test, with the same technical specifications as the Type B package thermal test but with a duration of 60 minutes;
- a 200-m water immersion test; and
- an impact speed of 90 m/s for the "drop" test.

Type C package designs will require unilateral Competent Authority approval unless they contain fissile material which requires multilateral approval. There are no "grandfathering" provisions for Type C packages which means that as soon as the 1996 revision is implemented by Member States or the International Civil Aviation Organization, they will be required.

There is recognition that NUREG-0360 (NRC 1978) is more stringent than the require ments contained in the Regulations. NUREG-0360, inspired by political mandate, seeks almost absolute protection irrespective of the probability of occurrence of an accident. It was recognized that there are differences, such as the required impact velocity and the sequencing of tests. Following a re-evaluation of the data provided by France and the United States, it was agreed that both data sets support an impact speed of 90 m/s as contrasted with the NUREG-0360 requirement of 129 m/s.

Since the primary hazards being addressed in Type C requirements are dispersion and radiation levels, provisions have been made for materials which exhibit limited dispersibility, solubility, and radiation levels. These provisions are contained in a material category known as "low dispersible material" (LDM). It was accepted that material (without any packaging) that has limited radiation levels, which when subjected to the Type C impact and thermal test would only produce limited gaseous, fine particulate, or dissolved aqueous activity (less than 100 A_2) should be excepted from the Type C packaging requirements. Test specifications for LDM material are included in the Regulations and Type B packages are authorized for their transport by air with the limit on total activity only being that specified in the approval certificate for the Type B package. Multilateral Competent Authority approval of the Type B package design and

the design of the LDM is required.

Packaging Requirements for Uranium Hexafluoride

The Revision Panel has accepted most of the regulatory provisions for the transport of uranium hexafluoride (UF_6), as presented in IAEA-TECDOC-608, "Interim Guidance on the Safe Transport of Uranium Hexafluoride" (IAEAf). It was originally recommended that all of the requirements be placed into a new section of Safety Series No. 6, but reliance on the International Organization for Standardization document ISO 7195:1993(E) sufficiently reduced the requirements needed in the regulations so they could be placed in the existing familiar structure. The decision to draft regulations for a specific material reflects the importance of UF_6 within the nuclear fuel cycle, the very large quantities being shipped, and the peculiar physical and chemical properties of the material.

The Revision Panel dealt with a number of difficult items concerning UF_6. Namely, cylinder pressure test requirements, the specification of the thermal test, criticality safety, and the need for Competent Authority design approval. In the end it was decided to require that packages:

- must withstand an internal test pressure of at least 1.4 MPa, but cylinders with a test pressure less than 2.8 MPa require multilateral approval;
- must withstand the "Type A" drop test, with graduated heights from 0.3 to 1.2 m, depending on package mass;
- designed to contain 0.1 kg or more but less than 9,000 kg of UF_6 must meet the "Type B" thermal test of 800°C for 30 minutes;
- designed to contain 9,000 kg or more must either meet the thermal test requirements or have multilateral approval;
- containing fissile UF_6 must meet the test conditions applicable to fissile packages ("Type B" impact and thermal tests) with no contact between the valve and other normally noncontacting parts of the packaging, have no leakage from the valve, and meet other operational requirements before the designer can assume no in leakage of water for the safety analysis; and
- have at least unilateral Competent Authority design approval after 31 December 2003, with certain exceptions (test pressure less than 2.8 MPa or not meeting the thermal test) where multilateral approval is required after 31 December 2000.

A Coordinated Research Programme (CRP) has been undertaken to develop accurate, validated analytical codes for calculating the thermal response of standard shipping cylinders containing UF_6. The results of the CRP are expected to aid in the determination of whether the bare cylinders, particularly the 48Y, can successfully pass the 30 minute thermal test.

Creating Two Package Indexes

Proposals to create two separate package indexes have been accepted by the Revision Panel. The transport index (TI) for radiation protection is unchanged and continues to be based on the radiation level at 1 m. A new criticality safety index (CSI) is based on the

allowable number of packages that can be transported together. Currently, the transport index fulfills a dual function in controlling both hazards. Separation of the two indices will allow shipments to be controlled on the basis of the specific value of concern. For example, fissile packages with low radiation levels will not have to be segregated from persons on the basis of a high TI. Additionally, several tables in the Regulations will be simplified, since two simple rules are being substituted for the more complex combination of possible consignment make-ups. The changes introduce clarity which should enhance compliance with the regulations.

New UN Numbers

The primary purpose of displaying UN numbers on packages, and on conveyances when appropriate, is to key into emergency response procedures in a language-independent way. It was felt that an expanded set of UN numbers would provide emergency workers with more specific response guidance.

Under the new system a UN number is assigned to each of the Schedules appended to the Regulations, with a set of numbers for packages containing fissile material. UN numbers are retained for uranium hexafluoride because of its importance as a commercial substance and its subsidiary (corrosive) risk. The new UN numbers will facilitate emergency response procedures and help with compliance checks and controls through a numerical link with the Schedules. The 1995 Edition of the UN Recommendations for the Transport of Dangerous Goods (the Orange Book) includes the new UN numbers. Some UN numbers become redundant, but as none of the deleted numbers are re-used the transition process will be eased.

Criticality Safety

The provisions for criticality safety were also comprehensively reviewed and several significant changes were adopted. These changes include revisions of existing provisions and several new packaging performance requirements. Specifically, the revised require ments include:

- revised fissile exception limits, including a "fissile mass per consignment" limit for packages containing: less than 15 g of fissile material; hydrogenous solutions with an X/H ratio less than 5% by mass; and, material with no more than 5 g of fissile material in any 10-litre volume;
- only one type of fissile exception being allowed per consignment;
- a requirement for a measurement to be performed after irradiation but prior to shipment in the case of using "burnup credit" in the package design;
- if intended for air transport, the package must remain subcritical under conditions consistent with the Type C tests, but without consideration of water in leakage; and
- applicability of the Type B "crush test" for low density (less than 1,000 kg/m^3), lightweight (less than 500 kg) packages designed for non-excepted fissile material.

THE NEXT STEPS

Technical discussions on the 1996 edition of the Transport Regulations are now completed. Following a Consultants Service Meeting in November 1995 to peer review the fourth draft, a final draft will be prepared and distributed for information to Member States that participated in the revision process. TRANSSAC will be requested to approve the final draft in March 1996. Since all of the TRANSSAC Member States have been actively involved in the revision process, approval of the final draft is anticipated. Following this meeting the final draft of the document will be prepared and submitted for approval to the Board of Governors in 1996.

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