CATEGORIES OF IAEA SAFETY SERIES

From 1978 onwards the various publications in the Safety Series are divided into four categories, as follows:

(1) **IAEA Safety Standards.** Publications in this category comprise the Agency’s safety standards as defined in “The Agency’s Safety Standards and Measures”, approved by the Agency’s Board of Governors on 25 February 1976 and set forth in IAEA document INFCIRC/18/Rev.1. They are issued under the authority of the Board of Governors, and are mandatory for the Agency’s own operations and for Agency-assisted operations. Such standards comprise the Agency’s basic safety standards, the Agency’s specialized regulations and the Agency’s codes of practice. *The covers are distinguished by the wide red band on the lower half.*

(2) **IAEA Safety Guides.** As stated in IAEA document INFCIRC/18/Rev.1, referred to above, IAEA Safety Guides supplement IAEA Safety Standards and recommend a procedure or procedures that might be followed in implementing them. They are issued under the authority of the Director General of the Agency. *The covers are distinguished by the wide green band on the lower half.*

(3) **Recommendations.** Publications in this category, containing general recommendations on safety practices, are issued under the authority of the Director General of the Agency. *The covers are distinguished by the wide brown band on the lower half.*

(4) **Procedures and Data.** Publications in this category contain information on procedures, techniques and criteria pertaining to safety matters. They are issued under the authority of the Director General of the Agency. *The covers are distinguished by the wide blue band on the lower half.*

*Note: The covers of publications brought out within the framework of the NUSS (Nuclear Safety Standards) Programme are distinguished by the wide yellow band on the upper half.*
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<td>SAUDI ARABIA</td>
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<td>SENEGAL</td>
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<td>SWITZERLAND</td>
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<td>SYRIAN ARAB REPUBLIC</td>
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<td>UNITED KINGDOM OF GREAT</td>
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<td>MONACO</td>
<td>BRITAIN AND NORTHERN</td>
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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

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SAFETY SERIES No.6 — Suppl. 1988

REGULATIONS
FOR THE SAFE TRANSPORT
OF RADIOACTIVE MATERIAL
1985 EDITION

SUPPLEMENT 1988

(INCLUDING UPDATES TO
SAFETY SERIES Nos 7, 37 AND 80)

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 1988
FOREWORD

A major revision of the Agency’s Regulations for the Safe Transport of Radioactive Material, Safety Series No. 6, was undertaken during a period of several years, culminating in the publication of the 1985 Edition. In order to consider minor problems in the new edition, the Agency convened a panel of experts in January 1986. This panel recommended some amendments which were subsequently published as Supplement 1986 to the Regulations.

The panel also recommended a procedure for the future review of the Regulations based on biennial panel meetings. According to the procedure, changes recommended by the review panels would, after receiving appropriate endorsement, be published as additional Supplements to the Regulations. Corresponding supplementary material would also be published, as necessary, in the case of the supporting documents to the Regulations, namely the Explanatory Material (1985 Edition), Safety Series No. 7, Second Edition; the Advisory Material (1985 Edition), Safety Series No. 37, Third Edition; and the Schedule of Requirements for the Transport of Specified Types of Radioactive Material Consignments, Safety Series No. 80.

An additional recommendation of the panel was that the need for more comprehensive revision of the Regulations to incorporate more significant changes should be assessed periodically.

The panel’s recommendations were endorsed by the Standing Advisory Group on the Safe Transport of Radioactive Material (SAGSTRAM). This review procedure has accordingly been adopted by the Agency and placed under the supervision of SAGSTRAM.

A further review panel meeting took place in June 1987. As recommended by SAGSTRAM, Member States were requested to submit in advance any problems identified and any proposals for changes to the Regulations. The submissions were then circulated to all Member States for comments. The initial submissions and the subsequent comments on them were assessed by the review panel, which identified possible changes to the Regulations for immediate implementation, as well as some items of greater significance which were brought to the attention of SAGSTRAM.

The amendments which were recommended for early adoption were themselves divided into two kinds. The first of these are designated as minor changes, according to the review procedure recommended by SAGSTRAM. These include the correction of errors in the presentation of the text; translation errors (in the French, Russian and Spanish versions of the 1985 Edition), and drafting errors which failed
to express the intent of the panels which reviewed the previous edition of the Regulations; these minor changes are promulgated herewith by the authority of the Director General.

The second kind of amendment recommended for early adoption comprises actual changes to regulatory provisions. These so called 'changes of detail' can only be introduced in accordance with the procedure approved by the IAEA Board of Governors on 22 September 1972, which authorizes the Director General to promulgate such changes after giving Member States not less than ninety days' notice and taking into account any comments that they make. Several changes of this second type were recommended by the panel, and were circulated according to the 'ninety-day rule' amendment procedure on 25 August 1987. Those changes which received unanimous support by Member States are included in this Supplement.

The Supplement also contains the amended texts of the supporting documents, Safety Series Nos 7, 37 and 80, which are necessary to correct minor errors as well as to provide complementary information for the changes introduced to the Regulations themselves.

In addition, the Supplement embodies the contents of Supplement 1986, which is consequently superseded.
The following pages replace the corresponding pages of the Regulations for the Safe Transport of Radioactive Material, Safety Series No. 6, 1985 Edition. They also incorporate the contents of Supplement 1986 to Safety Series No. 6.

 Modifications are marked with a vertical line in the right margin of the text for easy location.

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FOREWORD

As a result of a comprehensive review carried out by panels of experts convened by the International Atomic Energy Agency starting in 1979, a revised version of the Agency's Regulations for the Safe Transport of Radioactive Materials (Safety Series No.6) was approved by the Board of Governors in September 1984. This edition supersedes all the previous editions of the Regulations issued under Safety Series No.6.

The Agency first published Safety Series No.6 in 1961 for application to the national and international transport of radioactive materials by all means of transport. Subsequent reviews, carried out in consultation with Member States and the organizations concerned, resulted in three comprehensive revisions being published in 1964, 1967, and 1973 respectively. An amended version was further published in 1979 as the 1973 Revised Edition (As Amended) 1979.

In approving the first revision in 1964, the Board of Governors authorized the Director General to apply the Regulations, as appropriate, to Agency operations and Agency-assisted operations and to recommend to Member States and to the organizations concerned that the Regulations be taken as a basis for corresponding national regulations and be applied to international transport. By 1969, the Agency's Regulations had been adopted by almost all international organizations concerned with transport and taken by many Member States as the basis for their own regulations.

Through the adoption of the Agency's Regulations for multimodal transport and worldwide application, a very high standard of safety in transport has been achieved. In the reviews carried out since the first edition, attempts have been made to strike a balance between the need to take account of technical advances and operational experience, and the desirability of providing a stable framework of regulatory requirements. One of the aims of this approach is to permit packages approved under an earlier version of the Regulations to continue to be used to the end of their useful lives. It is further recognized that not all regulatory changes can be implemented simultaneously; Member States and concerned international organizations are therefore invited, in adopting this revision, to provide for optional implementation of either the 'old' requirements or the 'new' ones during a period of transition which may last for a few years. It is further recommended that adoption of these revised Regulations occurs in a period of 3 to 5 years, i.e. no later than 1990, with the view to achieving worldwide harmonization of their application.

The International System of Units (SI) is used throughout this edition of the Regulations as the primary units. It is recognized, however, that some...
time will be required for the conversion of instruments and techniques from the existing units to SI units and for training personnel in the use of the SI units; therefore, units used in the previous edition of the Regulations have also been included within parentheses in this edition to facilitate implementation of the standards. In many cases, owing to rounding off of the numbers, the two values for a given parameter for the two units differ somewhat. With the aim of moving towards international use of SI units and avoiding inconsistencies, the values for the SI units are controlling in all cases.

All terms which are defined in Section I are shown throughout the text in bold type when used in the defined sense to enhance recognition of these terms.

Schedules listing in an abbreviated form the requirements to be met for the transport of specified types of consignments were included in both the 1973 and the 1973 As Amended Editions of Safety Series No.6. These Schedules did not provide all of the regulatory requirements, and have therefore been removed from the 1985 Edition. Current versions of the Schedules, cross-referenced to the 1985 Edition of Safety Series No.6 will be issued as a separate IAEA Safety Series document.

The Agency published in 1973 a companion document to the 1973 Revised Edition of the Regulations, entitled 'Advisory Material for the Application of the IAEA Transport Regulations', IAEA Safety Series No.37. An updated version was published as the Second Edition in 1982, and a third edition will be issued reflecting the present edition of Safety Series No.6. Safety Series No.37 provides information about the intent and implications of the technical requirements of the Regulations and about methods and technology which may be employed to fulfil them, for the benefit of designers and manufacturers of packagings, consignors, carriers, competent authorities and others. Member States and international organizations concerned are invited to take note of such 'Advisory Material' and to bring it to the attention of persons and organizations who make use of, or are subject to, these Regulations.

Another companion document to Safety Series No. 6 has been published, entitled 'Explanatory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (1985 Edition)', Safety Series No. 7, Second Edition. This document supersedes an earlier version entitled 'Notes on Certain Aspects of the Regulations', Safety Series No. 7, which was published in 1961. It provides explanatory information on the intent and rationale of the regulatory requirements; the so-called 'why' of these provisions. Its purpose is to assist comprehension of the regulatory standards, so as to promote compliance, public acceptance and further development in relation to them.

Safety Series No. 7 reflects the corrections and changes implemented by the 1986 Supplement to the Regulations for the Safe Transport of Radioactive Material. It additionally includes appendices which explain the Q system and the derivation of $A_1$ and $A_2$ values, and the basis for the allowable release rates for Type B packages.
Member States and international organizations concerned are invited to take note of this 'Explanatory Material' and to bring it to the notice of persons and organizations affected by these Regulations.


The 1961 Edition of the Agency's Regulations for the Safe Transport of Radioactive Materials was based on the then applicable recommendations of the International Commission on Radiological Protection (ICRP) and on radiation protection principles in current use at that time. Subsequent revisions of the Transport Regulations have been based on the 1962 and 1967 Editions of the Basic Safety Standards for Radiation Protection, which reflected the then applicable ICRP recommendations.

This revision of the Transport Regulations implements the 1982 Edition of the Basic Safety Standards for Radiation Protection which sets forth a new system of dose limitation, the components of which are: (1) justification of the practice, (2) optimization of protection for sources of exposure, and (3) individual dose limitation.

The safe transport of radioactive materials has become an important part of national and international programmes for the use of radioactive materials in medicine, agriculture, industry and research, and the generation of nuclear power, and it is thus generally agreed that there is ample justification for such uses of radioactive material.

The requirement of the optimization component of the system of dose limitation establishes that planning, designing, using or operating of sources and practices shall be performed in such a manner that exposures are as low as reasonably achievable, economic and social factors being taken into account. The Basic Safety Standards include differential cost-benefit techniques as a practical form of guidance for performing optimization of radiation protection. They also suggest that, in any further reduction in exposures economic and social factors should be taken into account so as to ensure the best use of available resources in bringing about that reduction. With regard to protection in the transport of radioactive materials, consideration must be given to optimization of (1) requirements related to package design and test requirements including quantity and external radiation level limitations and (2) operational requirements for the implementation of, and compliance with, the Agency's Regulations.

The specific provisions of the Agency's Regulations deal primarily with requirements related to package design and test requirements. As the Regulations
have evolved, consideration has consistently been given to the principle of keeping radiation exposures as low as practicable. Experience has shown that compliance with the Agency's Regulations ensures a high degree of safety. However, the new emphasis on optimization in the current edition of the Basic Safety Standards for Radiation Protection made it necessary to re-examine the provisions of the Transport Regulations and provide a more definitive determination that appropriate consideration has been given to optimization of such provisions. This requires data on exposure levels to workers and the public that have been incurred under existing provisions of the Regulations, and on differential costs and benefits for various alternatives to present provisions, as well as further development of the methodology that should be applied in the optimization of protection in the transport of radioactive materials. In preparing this revision of the Regulations, the Secretariat, with the assistance of advisory groups and consultants, has examined the very limited data available on estimates of collective doses, supported by actual measurements, from the transport of radioactive materials in a few Member States. Based on these limited data it appears that the collective doses are sufficiently low and, therefore, it is doubtful that a differential cost-benefit analysis would favour the implementation of alternatives to the provisions of these revised Regulations that would substantially reduce further the collective dose, with the use of any one of a wide range of monetary values for the unit of collective dose that have been suggested in the relevant literature. This is a tentative conclusion based on limited data. Work on optimization of protection in the transport of radioactive material will continue in the Agency and should continue in the Member States to assure that data and methodology are developed.

For individual members of the public, the dose limits set forth in the Basic Standards for Radiation Protection apply to the critical group of the population and to the total individual dose from all sources of exposure, excluding natural background and medical exposure of patients. In practice, to take into account other sources of exposure, requirements in these revised Regulations for segregating radioactive material packages from members of the public are formulated on the basis of conservative assumptions in the definition of the critical group, to provide reasonable assurance that actual doses from transport of such packages will not exceed a small fraction of the dose limits.

The responsibility for the development and optimization of operational requirements for the implementation and compliance with the Agency's Regulations rests with Competent Authorities in Member States and with the international organizations concerned. Recognizing the need for further guidance in this area, the Agency plans to develop, in consultation with Member States, a Safety Series 'Guide for Optimization of Radiation Protection in the Transport of Radioactive Materials'.
CONTENTS

(Paragraph numbers are given in parentheses)

SECTION I.  INTRODUCTION ................................................................. 1
Purpose and scope (101—109) ................................................................. 1
Definitions for the purpose of these Regulations (110—152) .......... 2

SECTION II.  GENERAL PROVISIONS ............................................. 13
Radiation protection (201—206) ......................................................... 13
Emergency response (207—208) ....................................................... 14
Quality assurance (209) ................................................................. 15
Compliance assurance (210) ............................................................. 15
Special arrangement (211) ............................................................. 15

SECTION III.  ACTIVITY AND FISSILE MATERIAL LIMITS ......... 17
Basic $A_1/A_2$ values (301) ............................................................ 17
Determination of $A_1$ and $A_2$ (302—306) ....................................... 17
Contents limits for packages (307—315) ........................................ 30

SECTION IV.  PREPARATION, REQUIREMENTS AND CONTROLS
FOR SHIPMENT AND FOR STORAGE IN TRANSIT .................. 33
Package inspection requirements (401—402) ........................................ 33
Transport of other goods (403—406) .................................................. 34
Other dangerous properties of contents (407) ..................................... 34
Requirements and controls for contamination and for leaking packages (408—414) .......................................................... 35
Requirements and controls for transport of excepted packages .... (415—421) .......................................................... 36
Requirements and controls for transport of LSA material and SCO in industrial packages or unpackaged (422—427) ................................................. 38
Determination of transport index (TI) (428—431) ............................... 40
Additional requirements for overpacks (431) .................................... 41
Limits on transport index and radiation level for packages and overpacks (432—434) .................................................. 44
LIST OF MEETINGS RELATING TO THE 1985 EDITION OF SAFETY SERIES No.6 AND OF PARTICIPANTS AT THOSE MEETINGS .................... 99

INDEX .................................................................................................................................................. 107

LIST OF TABLES

Table I A₁ and A₂ values for radionuclides .................................................................................. 18
Table II General values for A₁ and A₂ ............................................................................................ 30
Table III Limits of non-fixed contamination on surfaces .............................................................. 35
Table IV Activity limits for excepted packages ............................................................................ 37
Table V Industrial package integrity requirements for LSA material and SCO ......................... 39
Table VI Conveyance activity limits for LSA material and SCO in industrial packages or unpackaged ............................................................ 40
Table VII Multiplication factors for large dimension loads .......................................................... 41
Table VIII Determination of transport index ................................................................................ 42
Table IX Categories of packages .................................................................................................. 44
Table X Categories of overpacks including freight containers when used as overpacks ............. 44
Table XI TI limits for freight containers and conveyances ............................................................. 54
Table XII Insolation data ............................................................................................................... 67
Table XIII Limitations on homogeneous hydrogenous solutions or mixtures of fissile material ........................................................................... 70
Table XIV Free drop distance for testing packages to normal conditions of transport ................ 79

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Consignor

120. **Consignor** shall mean any individual, organization or government which presents a **consignment** for transport, and is named as consignor in the transport documents.

Containment system

121. **Containment system** shall mean the assembly of components of the **packaging** specified by the designer as intended to retain the **radioactive material** during transport.

Contamination

122. **Contamination** shall mean the presence of a radioactive substance on a surface in quantities in excess of $0.4 \text{ Bq/cm}^2$ ($10^{-5} \mu\text{Ci/cm}^2$) for beta and gamma emitters and low toxicity alpha emitters, or $0.04 \text{ Bq/cm}^2$ ($10^{-6} \mu\text{Ci/cm}^2$) for all other alpha emitters. Low toxicity alpha emitters are: natural uranium; depleted uranium; natural thorium; uranium-235; uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores, or physical or chemical concentrates; or alpha emitters with a half-life of less than 10 days.

123. **Fixed contamination** shall mean contamination other than **non-fixed contamination**.

124. **Non-fixed contamination** shall mean contamination that can be removed from a surface during normal handling.

Conveyance

125. **Conveyance** shall mean

(a) for transport by road or rail: any vehicle,
(b) for transport by water: any vessel, or any hold, compartment, or **defined deck area** of a vessel, and
(c) for transport by air: any **aircraft**.

Defined deck area

126. **Defined deck area** shall mean the area, of the weather deck of a vessel, or of a **vehicle** deck of a roll-on/roll-off ship or a ferry, which is allocated for the stowage of **radioactive material**.

Design

127. **Design** shall mean the description of **special form radioactive material**, **package**, or **packaging** which enables such an item to be fully identified. The
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(ii) Solid unirradiated natural uranium or depleted uranium or natural thorium or their solid or liquid compounds or mixtures; or
(iii) Radioactive material, other than fissile material, for which the $A_2$ value is unlimited.

(b) LSA-II

(i) Water with tritium concentration up to 0.8 TBq/L (20 Ci/L); or
(ii) Other material in which the activity is distributed throughout and the estimated average specific activity does not exceed $10^{-4} \ A_2/g$ for solids and gases, and $10^{-5} \ A_2/g$ for liquids.

(c) LSA-III

Solids (e.g. consolidated wastes, activated materials) in which:

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

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

(iii) The estimated average specific activity of the solid, excluding any shielding material, does not exceed $2 \times 10^{-3} \ A_2/g$.

Maximum normal operating pressure

132. Maximum normal operating pressure shall mean the maximum pressure above atmospheric pressure at mean sea-level that would develop in the containment system in a period of one year under the conditions of temperature and solar radiation corresponding to environmental conditions of transport in the absence of venting, external cooling by an ancillary system, or operational controls during transport.

Overpack

133. Overpack shall mean an enclosure, such as a box or bag, which need not meet the requirements for a freight container and which is used by a single consignor to consolidate into one handling unit a consignment of two or more packages for convenience of handling, stowage, and carriage.

Package

134. Package shall mean the packaging with its radioactive contents as presented for transport. Package and packaging performance standards, in terms of retention...
of integrity of containment and shielding, depend upon the quantity and nature of the radioactive material transported. Performance standards applied are graded to take into account conditions of transport characterized by the following severity levels:

- conditions likely to be encountered in routine transport (in incident-free conditions),
- normal conditions of transport (minor mishaps), and
- accident conditions of transport.

The performance standards include design requirements and tests. Each package shall be classified as follows:

(a) **Excepted package** is a packaging containing radioactive material (see paras 418—420) that is designed to meet the General Requirements for All Packagings and Packages (see paras 505—514).

(b) (I) **Industrial package Type 1 (IP-1)** is a packaging, tank, or freight container containing LSA material or surface contaminated object (SCO) (see paras 131, 144 and 426) that is designed to meet the General Design Requirements for All Packagings and Packages (see paras 505—514) and the requirements of paras 515—517 if carried by air;

(II) **Industrial package Type 2 (IP-2)** is a packaging, tank, or freight container containing LSA material or SCO (see paras 131, 144 and 426), that is designed to meet the General Requirements for All Packagings and Packages (see paras 505—514), the requirements of paras 515—517 if carried by air, and, in addition, the following Specific Design Requirements:

(i) for a package, see para. 519,
(ii) for a tank, see paras 521—522, and
(iii) for a freight container, see para. 523;

(III) **Industrial package Type 3 (IP-3)** is a packaging, tank, or freight container containing LSA material or SCO (see paras 131, 144 and 426), that is designed to meet the General Requirements for All Packagings and Packages (see paras 505—514), the requirements of paras 515—517 if carried by air, and, in addition, the following Specific Design Requirements;

(i) for a package, see para. 520,
(ii) for a tank, see paras 521—522, and
(iii) for a freight container, see para. 523.

(c) **Type A package** is a packaging, tank, or freight container containing an activity up to $A_1$ if special form radioactive material, or up to $A_2$ if not special form radioactive material, that is designed to meet the General Requirements for All Packagings and Packages (see paras 505—514), the requirements of
(d) **Type B package** is a **packaging, tank, or freight container** containing an activity that may be in excess of $A_1$, if **special form radioactive material**, or in excess of $A_2$ if not **special form radioactive material**, that is designed to meet the General Design Requirements for All Packagings and Packages (see paras 505–514), the requirements of paras 515–517 if carried by air, and the Specific Design Requirements in paras 525–538 and 541–558, as appropriate.

### Packaging

135. **Packaging** shall mean the assembly of components necessary to enclose the **radioactive contents** completely. It may, in particular, consist of one or more receptacles, absorbent materials, spacing structures, radiation shielding, service equipment for filling, emptying, venting and pressure relief, devices for cooling, for absorbing mechanical shocks, for providing handling and tie-down capability, and for thermal insulation, and service devices integral to the **package**. The **packaging** may be a box, drum, or similar receptacle, or may also be a **freight container**, or **tank** consistent with para. 134.

### Quality assurance

136. **Quality assurance** shall mean a systematic programme of controls and inspections applied by any organization or body involved in the transport of **radioactive material** which is aimed at providing adequate confidence that the standard of safety prescribed in these Regulations is achieved in practice.

### Radiation level

137. **Radiation level** shall mean the corresponding dose-equivalent rate expressed in millisieverts (previously millirem) per hour. (Note: it is recognized that millisieverts or millirem are not the correct units that should apply to radiation exposures in all cases; nevertheless, these units are used exclusively in these Regulations for convenience.)

### Radioactive contents

138. **Radioactive contents** shall mean the **radioactive material** together with any contaminated solids, liquids, and gases within the **packaging**.

### Radioactive material

139. **Radioactive material** shall mean any material having a **specific activity** greater than 70 kBq/kg (2 nCi/g).
Shipment

140. Shipment shall mean the specific movement of a consignment from origin to destination.

Special arrangement

141. Special arrangement shall mean those provisions, approved by the competent authority, under which a consignment which does not satisfy all the applicable requirements of these Regulations may be transported. For international shipments of this type multilateral approval is required. See para. 211.

Special form radioactive material

142. Special form radioactive material shall mean either an indispersible solid radioactive material or a sealed capsule containing radioactive material. See paras 502–504.

Specific activity

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

Surface contaminated object

144. Surface contaminated object (SCO) shall mean a solid object which is not itself radioactive but which has radioactive material distributed on its surfaces. SCO shall be in one of two groups:

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

(i) the non-fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 4 Bq/cm² \( (10^{-4} \mu Ci/cm^2) \) for beta and gamma emitters and low toxicity alpha emitters, or 0.4 Bq/cm² \( (10^{-5} \mu Ci/cm^2) \) for all other alpha emitters; and

(ii) the fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed \( 4 \times 10^4 \) Bq/cm² \( (1 \mu Ci/cm^2) \) for beta and gamma emitters and low toxicity alpha emitters, or \( 4 \times 10^3 \) Bq/cm² \( (0.1 \mu Ci/cm^2) \) for all other alpha emitters; and

(iii) the non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed \( 4 \times 10^4 \) Bq/cm² \( (1 \mu Ci/cm^2) \) for beta and gamma emitters and low toxicity alpha emitters, or \( 4 \times 10^3 \) Bq/cm² \( (0.1 \mu Ci/cm^2) \) for all other alpha emitters.
(b) **SCO-II**: A solid object on which either the **fixed** or **non-fixed contamination** on the surface exceeds the applicable limits specified for **SCO-I** in (a) above and on which:

(i) the **non-fixed contamination** on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 400 Bq/cm² \((10^{-2} \muCi/cm^2)\) for beta and gamma emitters and low toxicity alpha emitters, or 40 Bq/cm² \((10^{-3} \muCi/cm^2)\) for all other alpha emitters; and

(ii) the **fixed contamination** on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed \(8 \times 10^5\) Bq/cm² \((20 \muCi/cm^2)\) for beta and gamma emitters and low toxicity alpha emitters, or \(8 \times 10^4\) Bq/cm² \((2 \muCi/cm^2)\) for all other alpha emitters; and

(iii) the **non-fixed contamination** plus the **fixed contamination** on the inaccessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed \(8 \times 10^5\) Bq/cm² \((20 \muCi/cm^2)\) for beta and gamma emitters and low toxicity alpha emitters, or \(8 \times 10^4\) Bq/cm² \((2 \muCi/cm^2)\) for all other alpha emitters.

**Tank**

145. **Tank** shall mean a tank container, portable tank, a road tank vehicle, a rail tank wagon or a receptacle with a capacity of not less than 450 litres intended to contain liquids, powders, granules, slurries or solids which are loaded as gas or liquid and subsequently solidified, and of not less than 1000 litres intended to contain gases. A tank container shall be capable of being carried on land or on sea and of being loaded and discharged without the need of removal of its structural equipment, shall possess stabilizing members and tie-down attachments external to the shell, and shall be capable of being lifted when full.

**Transport index**

146. **Transport index (TI)** shall mean a single number assigned to a package, overpack, tank or freight container, or to unpackaged **LSA-I** or **SCO-I**, which is used to provide control over both nuclear criticality safety and radiation exposure. It is also used to establish contents limits on certain packages, overpacks, tanks and freight containers; to establish categories for labelling; to determine whether transport under exclusive use shall be required; to establish spacing requirements during storage in transit; to establish mixing restrictions during transport under special arrangement and during storage in transit; and to define the number of packages allowed in a freight container or aboard a conveyance. See Section IV.

**Uncompressed gas**

147. **Uncompressed gas** shall mean gas at a pressure not exceeding ambient atmospheric pressure at the time the **containment system** is closed.
Unirradiated thorium

148. Unirradiated thorium shall mean thorium containing not more than $10^{-7}$ g of uranium-233 per gram of thorium-232.

Unirradiated uranium

149. Unirradiated uranium shall mean uranium containing not more than $10^{-6}$ g of plutonium per gram of uranium-235 and not more than 9 MBq (0.20 mCi) of fission products per gram of uranium-235.

Uranium — natural, depleted, enriched

150. Natural uranium shall mean chemically separated uranium containing the naturally occurring distribution of uranium isotopes (approximately 99.28% uranium-238, and 0.72% uranium-235 by mass). Depleted uranium shall mean uranium containing a lesser mass percentage of uranium-235 than in natural uranium. Enriched uranium shall mean uranium containing a greater mass percentage of uranium-235 than in natural uranium. In all cases, a very small mass percentage of uranium-234 is present.

Vehicle

151. Vehicle shall mean a road vehicle (including an articulated vehicle, i.e. a tractor and semi-trailer combination) or railroad car or railway wagon. Each trailer shall be considered as a separate vehicle.

Vessel

152. Vessel shall mean any seagoing vessel or inland waterway craft used for carrying cargo.
SECTION II

GENERAL PROVISIONS

RADIATION PROTECTION

201. The radiation exposure of transport workers and of the general public is subject to the requirements specified in the "Basic Safety Standards for Radiation Protection: 1982 Edition", Safety Series No.9, IAEA, Vienna (1982), jointly sponsored by the IAEA, ILO, NEA (OECD), WHO.

202. Radiation exposures from the handling, storage and transport of radioactive material shall be kept as low as reasonably achievable, economic and social factors being taken into account. Compliance with these Regulations and with the Basic Safety Standards for Radiation Protection will ensure a high degree of safety, but managers and workers have a continuous responsibility for maintaining safe working practices. Transport workers shall receive appropriate training (to the extent necessary, considering the type of work) concerning the radiation hazards involved and the precautions to be observed.

203. The relevant competent authority shall arrange for periodic assessments to be carried out as necessary to evaluate the radiation doses to workers and to members of the public due to the transport of radioactive material, to (1) ensure the implementation of operational requirements for keeping radiation exposures as low as reasonably achievable, and (2) ensure that the system of dose limitation for transport workers and members of the public, as set forth in the Agency's Basic Safety Standards for Radiation Protection, are being complied with.

204. The nature and extent of the measures to be employed in controlling radiation exposures shall be related to the magnitude and likelihood of the exposures. Administrative requirements applicable to transport workers are set forth in Section V of the Basic Safety Standards for Radiation Protection. For individual occupationally exposed workers, where it is determined:

(a) That the dose received is most unlikely to exceed 5 mSv (500 mrem) per year, neither special work patterns nor detailed monitoring or assessment of radiation doses shall be required;

(b) That the dose received is likely to be between 5 mSv (500 mrem) and 15 mSv (1500 mrem) per year, periodic (as necessary) environmental monitoring and assessments of radiation exposure levels in work areas (including in conveyances) shall be conducted; and

(c) That the dose received is likely to be between 15 mSv (1500 mrem) and 50 mSv (5000 mrem) per year, individual radiation exposure monitoring programmes and special health supervision shall be required.
205. **Radioactive material** shall be segregated sufficiently from transport workers and from members of the public. For the purposes only of calculating segregation distances or dose rates in regularly occupied areas, different limiting values for dose shall be required:

(a) For transport workers, in the determination of segregation distances or dose rates in regularly occupied working areas, a dose level of 5 mSv (500 mrem) per year shall be used as the limiting value. This value, together with hypothetical but realistic mathematical models and parameters, shall be used to determine segregation distances or associated dose rates for transport workers.

(b) For members of the public, in the determination of segregation distances or dose rates in regularly occupied public areas or in areas where the public has regular access, a dose level of not more than 1 mSv (100 mrem) per year to the critical group shall be used as the limiting value. This value shall be used together with hypothetical but realistic models and parameters to determine segregation distances or dose rates for members of the public, with the objective of providing reasonable assurance that actual doses from transport of **radioactive material** will not exceed small fractions of the appropriate dose limits.

206. **Radioactive material** shall be sufficiently segregated from undeveloped photographic film. The basis for determining segregation distances for this purpose shall be that the radiation exposure of undeveloped photographic film due to the transport of **radioactive material** be limited to 0.1 mSv (10 mrem) per **consignment** of such film.

**EMERGENCY RESPONSE**

207. In the event of accidents during the transport of **radioactive material**, emergency provisions, as established by relevant national and/or international organizations, shall be observed in order to protect human health and minimize danger to life and property. Appropriate guidelines for such provisions are contained in “Advisory Material for the Application of the IAEA Transport Regulations: Second Edition”, Safety Series No.37, IAEA, Vienna (1982) and in “Emergency Response Planning for Transport Accidents Involving Radioactive Materials”, IAEA-TECDOC-262, IAEA, Vienna (1982).

208. Account shall be taken of the formation of other dangerous substances that may result from the reaction between the contents of a **consignment** and the atmosphere or water in the event of breaking of the **containment system** caused by an accident, e.g. UF₆ decomposition in a humid atmosphere.
QUALITY ASSURANCE

209. **Quality assurance** programmes shall be established for the design, manufacture, testing, documentation, use, maintenance and inspection of all packages and for transport and in-transit storage operations to ensure compliance with the relevant provisions of these Regulations. Where **competent authority** approval for design or shipment is required, such approval shall take into account and be contingent upon the adequacy of the **quality assurance** programme. Certification that the design specification has been fully implemented shall be available to the **competent authority**. The manufacturer, **consignor**, or user of any **package design** shall be prepared to provide facilities for **competent authority** inspection of the **packaging** during construction and use and to demonstrate to any cognizant **competent authority** that:

(a) The construction methods and materials used for the construction of the packaging are in accordance with the approved design specifications; and

(b) All packaging built to an approved design are periodically inspected and, as necessary, repaired and maintained in good condition so that they continue to comply with all relevant requirements and specifications, even after repeated use.

COMPLIANCE ASSURANCE

210. The **competent authority** is responsible for assuring compliance with these Regulations. Means to discharge this responsibility include the establishment and execution of a programme for monitoring the design, manufacture, testing, inspection and maintenance of packaging, and the preparation, documentation, handling and stowage of packages by consignors and carriers, to provide evidence that the provisions of these Regulations are being met in practice.

SPECIAL ARRANGEMENT

211. A consignment which does not satisfy all the applicable requirements of these Regulations shall not be transported except under **special arrangement**. Provisions may be approved by a **competent authority**, under which a consignment, which does not satisfy all of the applicable requirements of these Regulations, may be transported under **special arrangement**. These provisions shall be adequate to ensure that the overall level of safety in transport and in-transit storage is at least equivalent to that which would be provided if all the applicable requirements had been met. For international consignments of this type, **multilateral approval** shall be required.
TABLE I. (cont.)

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</tr>
<tr>
<td>$^{88}$Zr</td>
<td>Zirconium (40)</td>
<td>3</td>
<td>80</td>
<td>3</td>
<td>80</td>
</tr>
<tr>
<td>$^{93}$Zr</td>
<td></td>
<td>40</td>
<td>1000</td>
<td>0.2</td>
<td>5</td>
</tr>
<tr>
<td>$^{95}$Zr</td>
<td></td>
<td>1</td>
<td>20</td>
<td>0.9</td>
<td>20</td>
</tr>
<tr>
<td>$^{97}$Zr</td>
<td></td>
<td>0.3</td>
<td>8</td>
<td>0.3</td>
<td>8</td>
</tr>
</tbody>
</table>

*a The curie values quoted are obtained by rounding down from the TBq figure after conversion to Ci. This ensures that the magnitude of $A_1$ or $A_2$ in Ci is always less than that in TBq.

*b $A_1$ and/or $A_2$ value limited by daughter product decay.

*c $A_1$ and $A_2$ are unlimited for radiation control purposes only. For nuclear criticality safety this material is subject to the control placed on fissile material.
TABLE II. GENERAL VALUES FOR $A_1$ AND $A_2$

<table>
<thead>
<tr>
<th>Contents</th>
<th>$A_1$</th>
<th>$A_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TBq</td>
<td>(Ci)$^a$</td>
</tr>
<tr>
<td>Only beta or gamma emitting nuclides</td>
<td>0.2</td>
<td>(5)</td>
</tr>
<tr>
<td>are known to be present</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.02</td>
<td>(0.5)</td>
</tr>
<tr>
<td>Alpha emitting nuclides are known</td>
<td>0.1</td>
<td>(2)</td>
</tr>
<tr>
<td>to be present or no relevant data are available</td>
<td>$2 \times 10^{-5}$</td>
<td>$(5 \times 10^{-4})$</td>
</tr>
</tbody>
</table>

$^a$ The curie values quoted in parentheses are approximate values and are not higher than the TBq values.

Alternatively, an $A_2$ value for mixtures may be determined as follows:

$$A_2 \text{ for mixture} = \frac{1}{\sum_i f(i) A_2(i)}$$

where $f(i)$ is the fraction of activity of nuclide $i$ in the mixture and $A_2(i)$ is the appropriate $A_2$ value for nuclide $i$.

305. When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest $A_1$ or $A_2$ value, as appropriate, for the radionuclides in each group may be used in applying the formulas in para. 304. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest $A_1$ or $A_2$ values for the alpha emitters or beta/gamma emitters, respectively.

306. For individual radionuclides or for mixtures of radionuclides for which relevant data are not available, the values shown in Table II shall be used.

CONTENTS LIMITS FOR PACKAGES

307. The quantity of radioactive material in a package shall not exceed the relevant limits specified in paras 308—315.
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SECTION IV
PREPARATION, REQUIREMENTS AND CONTROLS FOR SHIPMENT AND FOR STORAGE IN TRANSIT

PACKAGE INSPECTION REQUIREMENTS

Before the first shipment

401. Before the first shipment of any package, the following requirements shall be fulfilled:

(a) If the design pressure of the containment system exceeds 35 kPa (0.35 kgf/cm²) (gauge), it shall be ensured that the containment system of each package conforms to the approved design requirements relating to the capability of that system to maintain its integrity under pressure.

(b) For each Type B package and for each packaging containing fissile material, it shall be ensured that the effectiveness of its shielding, containment system, and, where necessary, the heat transfer characteristics, are within the limits applicable to or specified for the approved design.

(c) For each packaging containing fissile material, where neutron poisons are specifically included as components of the package, in order to comply with the requirements of para. 559, tests shall be performed to confirm the presence and distribution of those neutron poisons.

Before each shipment

402. Before each shipment of any package, the following requirements shall be fulfilled:

(a) It shall be ensured that lifting attachments which do not meet the requirements of para. 506 have been removed or otherwise rendered incapable of being used for lifting the package.

(b) For each Type B package and for each packaging containing fissile material, it shall be ensured that all the requirements specified in the approval certificates and the relevant provisions of these Regulations have been satisfied.

(c) Each Type B package shall be held until equilibrium conditions have been approached closely enough to demonstrate compliance with the shipment requirements for temperature and pressure unless an exemption from these requirements has received unilateral approval.
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TABLE III. LIMITS OF NON-FIXED CONTAMINATION ON SURFACES

<table>
<thead>
<tr>
<th>Type of package, overpack, freight container, tank or conveyance and its equipment</th>
<th>Contaminant</th>
<th>Contaminant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applicable limit of beta and gamma emitters and low toxicity alpha emitters</td>
<td>Applicable limit of all other alpha emitters</td>
</tr>
<tr>
<td></td>
<td>Bq/cm² (μCi/cm²)</td>
<td>Bq/cm² (μCi/cm²)</td>
</tr>
<tr>
<td><strong>External surfaces of:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>excepted packages</td>
<td>0.4</td>
<td>0.04</td>
</tr>
<tr>
<td>other than excepted packages</td>
<td>4 (10⁻⁴)</td>
<td>0.4 (10⁻⁵)</td>
</tr>
<tr>
<td><strong>External and internal surfaces of overpacks, freight containers, and conveyances and their equipment, when used in or when being prepared for, the carriage of:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- loads consisting only of radioactive material in packages other than excepted packages</td>
<td>4 (10⁻⁴)</td>
<td>0.4 (10⁻⁵)</td>
</tr>
<tr>
<td>- loads including excepted packages and/or non-radioactive consignments</td>
<td>0.4</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(10⁻⁵)</td>
<td>(10⁻⁶)</td>
</tr>
<tr>
<td><strong>External surfaces of freight containers, tanks and conveyances and their equipment, used in the carriage of unpackaged radioactive material.</strong></td>
<td>4 (10⁻⁴)</td>
<td>0.4 (10⁻⁵)</td>
</tr>
</tbody>
</table>

*The limits are applicable when averaged over any area of 300 cm² of any part of the surface.*
REQUIREMENTS AND CONTROLS FOR CONTAMINATION AND FOR LEAKING PACKAGES

408. The non-fixed contamination on the external surfaces of a package shall be kept as low as practicable and, under conditions likely to be encountered in routine transport, shall not exceed the limits specified in Table III.

409. Except as provided in para. 414, the level of non-fixed contamination on the external and internal surfaces of overpacks, freight containers and tanks shall not exceed the limits specified in Table III.
410. If it is evident that a package is damaged or leaking, or if it is suspected that the package may have leaked or been damaged, access to the package shall be restricted and a qualified person shall, as soon as possible, assess the extent of contamination and the resultant radiation level of the package. The scope of the survey shall include the package, the conveyance, the adjacent loading and unloading areas, and, if necessary, all other material which has been carried in the conveyance. When necessary, additional steps for the protection of human health, in accordance with provisions established by the relevant competent authority, shall be taken to overcome and minimize the consequences of such leakage or damage.

411. Packages leaking radioactive contents in excess of allowable limits for normal conditions of transport may be removed under supervision but shall not be forwarded until repaired or reconditioned and decontaminated.

412. A conveyance and equipment used routinely for the carriage of radioactive material shall be periodically checked to determine the level of contamination. The frequency of such checks shall be related to the likelihood of contamination and the extent to which radioactive material is carried.

413. Except as provided in para. 414, any conveyance, or equipment or part thereof which has become contaminated above the limits specified in Table III, or which shows a radiation level in excess of 5 μSv/h (0.5 mrem/h), in the course of the carriage of radioactive material shall be decontaminated as soon as possible by a qualified person and shall not be re-used unless the non-fixed radioactive contamination does not exceed the limits specified in Table III, and the radiation level resulting from the fixed contamination on surfaces after decontamination is less than 5 μSv/h (0.5 mrem/h).

414. An overpack, freight container or conveyance dedicated to the transport of low specific activity material or surface contaminated objects under exclusive use shall be excepted from the requirements of paras 409 and 413 solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use.

REQUIREMENTS AND CONTROLS FOR TRANSPORT OF EXPECTED PACKAGES

415. Excepted packages shall be subject only to the following provisions in Sections IV and V:
(a) The requirements specified in paras 407, 416–421 as applicable, 436, 447(d), 447(l) and 452;
(b) The General Design Requirements for all packagings and packages specified in paras 505–514;
(c) If the excepted package contains fissile material, the requirements of para. 560; and
(d) The requirements in paras 476 and 477 if transported by post.

416. The radiation level at any point on the external surface of an excepted package shall not exceed 5 μSv/h (0.5 mrem/h).
TABLE IV. ACTIVITY LIMITS FOR EXCEPTED PACKAGES

<table>
<thead>
<tr>
<th>Physical state of contents</th>
<th>Instruments and articles</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Item limits(^a)</td>
<td>Package limits(^a)</td>
</tr>
<tr>
<td>Solids:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>special form</td>
<td>(10^{-2} A_1)</td>
<td>(A_1)</td>
</tr>
<tr>
<td>other forms</td>
<td>(10^{-2} A_2)</td>
<td>(A_2)</td>
</tr>
<tr>
<td>Liquids:</td>
<td>(10^{-3} A_2)</td>
<td>(10^{-1} A_2)</td>
</tr>
<tr>
<td>Gases:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tritium</td>
<td>(2 \times 10^{-2} A_2)</td>
<td>(2 \times 10^{-1} A_2)</td>
</tr>
<tr>
<td>special form</td>
<td>(10^{-3} A_1)</td>
<td>(10^{-2} A_1)</td>
</tr>
<tr>
<td>other forms</td>
<td>(10^{-3} A_2)</td>
<td>(10^{-2} A_2)</td>
</tr>
</tbody>
</table>

\(^a\) For mixtures of radionuclides, see paras 304–306.

417. The non-fixed radioactive contamination on any external surface of an excepted package shall not exceed the levels specified in Table III.

418. Radioactive material which is enclosed in or forms a component part of an instrument or other manufactured article, with activity not exceeding the item and package limits specified in columns 2 and 3 respectively of Table IV, may be transported in an excepted package provided that:

(a) The radiation level at 10 cm from any point on the external surface of any unpackaged instrument or article is not greater than 0.1 mSv/h (10 mrem/h); and

(b) Each instrument or article (except radioluminescent time-pieces or devices) bears the marking “Radioactive”.

419. Radioactive material in forms other than as specified in para. 418, with an activity not exceeding the limit specified in column 4 of Table IV, may be transported in an excepted package provided that:

(a) The package retains its contents under conditions likely to be encountered in routine transport; and
(b) The package bears the marking “Radioactive” on an internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.

420. A manufactured article in which the sole radioactive material is unirradiated natural uranium, unirradiated depleted uranium or unirradiated natural thorium may be transported as an excepted package provided that the outer surface of the uranium or thorium is enclosed in an inactive sheath made of metal or some other substantial material.

Additional requirements and controls for transport of empty packagings

421. An empty packaging which had previously contained radioactive material may be transported as an excepted package provided that:

(a) It is in a well-maintained condition and securely closed;
(b) The outer surface of any uranium or thorium in its structure is covered with an inactive sheath made of metal or some other substantial material;
(c) The level of internal non-fixed contamination does not exceed one thousand times the levels specified in Table III for excepted packages; and
(d) Any labels which may have been displayed on it in conformity with para. 440 are no longer visible.

REQUIREMENTS AND CONTROLS FOR TRANSPORT OF LSA MATERIAL AND SCO IN INDUSTRIAL PACKAGES OR UNPACKAGED

422. The quantity of LSA material or SCO in a single industrial package Type 1 (IP-1), industrial package Type 2 (IP-2), industrial package Type 3 (IP-3), or object or collection of objects, whichever is appropriate, shall be so restricted that the external radiation level at 3 m from the unshielded material or object or collection of objects does not exceed 10 mSv/h (1 rem/h).

423. LSA material and SCO which is or contains fissile material shall meet the applicable requirements of paras 479, 480 and 559.

424. Packages, including tanks or freight containers, containing LSA material or SCO shall be subject to the provisions of paras 408 and 409.

425. LSA material and SCO in groups LSA-I and SCO-I may be transported unpackaged under the following conditions:

(a) All unpackaged material other than ores containing only naturally occurring radionuclides shall be transported in such a manner that under conditions likely to be encountered in routine transport there will be no escape of the contents from the conveyance nor will there be any loss of shielding;
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TABLE VI. CONVEYANCE ACTIVITY LIMITS FOR LSA MATERIAL AND SCO IN INDUSTRIAL PACKAGES OR UNPACKAGED

<table>
<thead>
<tr>
<th>Nature of material</th>
<th>Activity limit for conveyances other than by inland water-way</th>
<th>Activity limit for a hold or compartment of an inland water craft</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSA-I</td>
<td>No limit</td>
<td>No limit</td>
</tr>
<tr>
<td>LSA-II and LSA-III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>non-combustible solids</td>
<td>No limit</td>
<td>100 A₂</td>
</tr>
<tr>
<td>LSA-II and LSA-III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>combustible solids, and all liquids and gases</td>
<td>100 A₂</td>
<td>10 A₂</td>
</tr>
<tr>
<td>SCO</td>
<td>100 A₂</td>
<td>10 A₂</td>
</tr>
</tbody>
</table>

DETERMINATION OF TRANSPORT INDEX (TI)

428. The transport index (TI) based on radiation exposure control for a package, overpack, tank, freight container, or for unpackaged LSA-I or SCO-I, shall be the number derived in accordance with the following procedure:

(a) Determine the maximum radiation level at a distance of 1 m from the external surfaces of the package, overpack, tank, freight container, or unpackaged LSA-I and SCO-I. Where the radiation level is determined in units of milli-sievert per hour (mSv/h), the value determined shall be multiplied by 100. Where the radiation level is determined in units of millirem per hour (mrem/h), the value determined is not changed. For uranium and thorium ores and concentrates, the maximum radiation dose rate at any point 1 m from the external surface of the load may be taken as:

- 0.4 mSv/h (40 mrem/h) for ores and physical concentrates of uranium and thorium
- 0.3 mSv/h (30 mrem/h) for chemical concentrates of thorium
- 0.02 mSv/h (2 mrem/h) for chemical concentrates of uranium, other than uranium hexafluoride.
TABLE VII. MULTIPLICATION FACTORS FOR LARGE DIMENSION LOADS

<table>
<thead>
<tr>
<th>Size of load</th>
<th>Multiplication factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>size of load &lt; 1 m²</td>
<td>1</td>
</tr>
<tr>
<td>1 m² &lt; size of load &lt; 5 m²</td>
<td>2</td>
</tr>
<tr>
<td>5 m² &lt; size of load &lt; 20 m²</td>
<td>3</td>
</tr>
<tr>
<td>20 m² &lt; size of load</td>
<td>10</td>
</tr>
</tbody>
</table>

\[ a \] Largest cross-sectional area of the load being measured.

(b) For tanks, freight containers and unpackaged LSA-I and SCO-I, the value determined in step (a) above shall be multiplied by the appropriate factor from Table VII.

(c) The figure obtained in steps (a) and (b) above shall be rounded up to the first decimal place (e.g. 1.13 becomes 1.2), except that a value of 0.05 or less may be considered as zero.

429. The transport index (TI) based on nuclear criticality control shall be obtained by dividing the number 50 by the value of N derived using the procedures specified in para. 567 (i.e. TI = 50/N). The value of the transport index for nuclear criticality control may be zero, provided that an unlimited number of packages is subcritical (i.e. N is effectively equal to infinity).

430. The transport index for each consignment shall be determined in accordance with Table VIII.

Additional requirements for overpacks

431. The following additional requirements shall apply to overpacks:

(a) Packages of fissile material for which the transport index for nuclear criticality control is 0 and packages of non-fissile radioactive material may be combined together in an overpack for transport, provided that each package contained therein meets the applicable requirements of these Regulations.

(b) Packages of fissile material for which the transport index for nuclear criticality control exceeds 0 shall not be carried in an overpack.

(c) Only the original consignor of the packages contained within the overpacks shall be permitted to use the method of direct measurement of radiation level to determine the transport index of a rigid overpack.
LIMITS ON TRANSPORT INDEX AND RADIATION LEVEL FOR PACKAGES AND OVERPACKS

432. Except for consignments under exclusive use, the transport index of any individual package or overpack shall not exceed 10.

433. Except for packages or overpacks transported under exclusive use by rail or by road under the conditions specified in subpara. 469(a), or under exclusive use and special arrangement by vessel or by air under the conditions specified in paras 471 or 475 respectively, the maximum radiation level at any point on any external surface of a package or overpack shall not exceed 2 mSv/h (200 mrem/h).

434. The maximum radiation level at any point on any external surface of a package under exclusive use shall not exceed 10 mSv/h (1000 mrem/h).

CATEGORIES

435. Packages and overpacks shall be assigned to either category I-WHITE, II-YELLOW or III-YELLOW in accordance with the conditions specified in Tables IX and X, as applicable, and with the following requirements:

(a) For a package, both the transport index and the surface radiation level conditions shall be taken into account in determining which is the appropriate category. Where the transport index satisfies the condition for one category but the surface radiation level satisfies the condition for a different category, the package shall be assigned to the higher category of the two. For this purpose, category I-WHITE shall be regarded as the lowest category.

(b) The transport index shall be determined following the procedures specified in paras 428-430, and subject to the limitation of para. 431(c).

(c) If the transport index is greater than 10, the package or overpack shall be transported under exclusive use.

(d) If the surface radiation level is greater than 2 mSv/h (200 mrem/h), the package or overpack shall be transported under exclusive use and under the provisions of paras 469(a), 471 and 475, as appropriate.

(e) A package transported under a special arrangement shall be assigned to category III-YELLOW.

(f) An overpack which contains packages transported under special arrangement shall be assigned to category III-YELLOW.

MARKING, LABELLING AND PLACARDING

Marking

436. Each package of gross mass exceeding 50 kg shall have its permissible gross mass legibly and durably marked on the outside of the packaging.
### TABLE IX. CATEGORIES OF PACKAGES

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transport index</strong></td>
<td><strong>Maximum radiation level at any point on external surface</strong></td>
</tr>
<tr>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Not more than 0.005 mSv/h (0.5 mrem/h)</td>
</tr>
<tr>
<td>More than 0 but not more than 1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>More than 0.005 mSv/h (0.5 mrem/h) but not more than 0.5 mSv/h (50 mrem/h)</td>
</tr>
<tr>
<td>More than 1 but not more than 10</td>
<td>More than 0.5 mSv/h (50 mrem/h) but not more than 2 mSv/h (200 mrem/h)</td>
</tr>
<tr>
<td>More than 10</td>
<td>More than 2 mSv/h (200 mrem/h) but not more than 10 mSv/h (1000 mrem/h) and also under exclusive use</td>
</tr>
</tbody>
</table>

<sup>a</sup> If the measured TI is not greater than 0.05, the value quoted may be zero in accordance with para. 428(c).

### TABLE X. CATEGORIES OF OVERPACKS INCLUDING FREIGHT CONTAINERS WHEN USED AS OVERPACKS

<table>
<thead>
<tr>
<th>Transport index</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>I-WHITE</td>
</tr>
<tr>
<td>TI greater than 0 but less than or equal to 1</td>
<td>II-YELLOW</td>
</tr>
<tr>
<td>TI greater than 1</td>
<td>III-YELLOW</td>
</tr>
</tbody>
</table>
437. Each package which conforms to a Type A package design shall be legibly and durably marked on the outside of the packaging with “TYPE A”.

438. Each package which conforms to a design approved under paras 704–714 shall be legibly and durably marked on the outside of the packaging with:
(a) The identification mark allocated to that design by the competent authority;
(b) A serial number to uniquely identify each packaging which conforms to that design; and
(c) In the case of a Type B(U) or Type B(M) package design, with “TYPE B(U)” or “TYPE B(M)”.

439. Each package which conforms to a Type B(U) or Type B(M) package design shall have the outside of the outermost receptacle which is resistant to the effects of fire and water plainly marked by embossing, stamping, or other means resistant to the effects of fire and water with the trefoil symbol shown in Fig. 1.

![FIG. 1. Basic trefoil symbol with proportions based on a central circle of radius X. The minimum allowable size of X shall be 4 mm.](image)

Labelling

440. Each package, overpack, tank and freight container shall bear the labels which conform to the models in Figs 2, 3 or 4, except as allowed under the alternative provision of para. 443 for large freight containers and tanks, according to the appropriate category. Any labels which do not relate to the contents shall be removed or covered. For radioactive material having other dangerous properties see para. 407.

441. The labels shall be affixed to two opposite sides of the outside of a package or overpack, or on the outside of all four sides of a freight container or tank.
FIG. 2. Category I-WHITE label. The background colour of the label shall be white, the colour of the trefoil and the printing shall be black, and the colour of the category bar shall be red.

442. Each label shall be completed with the following information:

(a) Contents:

(i) Except for LSA-I material, the name of the radionuclide as taken from Table I, using the symbols prescribed therein. For mixtures of radionuclides, the most restrictive nuclides must be listed to the extent the space on the line permits. The group of LSA or SCO shall be shown
FIG. 3. Category II-YELLOW label. The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

following the name of the radionuclide. The terms “LSA-II”, “LSA-III”, “SCO-I” and “SCO-II” shall be used for this purpose.

(ii) For LSA-I materials, the term “LSA-I” is all that is necessary; the name of the radionuclide is not necessary.

(b) Activity: The maximum activity of the radioactive contents during transport expressed in units of becquerels (Bq) (or curies (Ci)) with the appropriate SI prefix (see Appendix II). For fissile material, the total mass in units of grams (g), or multiples thereof, may be used in place of activity.
FIG. 4. Category III-YELLOW label. The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

(c) For overpacks, tanks, and freight containers, the 'contents' and 'activity' entries on the label shall bear the information required in subparas 442(a) and 442(b), respectively, totalled together for the entire contents of the overpack, tank, or freight container except that on labels for overpacks or freight containers containing mixed loads of packages with different radio- nuclides, such entries may read "See Transport Documents".

(d) Transport index: See para. 430. (No transport index entry required for category I-WHITE.)
Placarding

443. Large freight containers carrying packages other than excepted packages, and tanks shall bear four placards which conform with the model given in Fig. 5. The placards shall be affixed in a vertical orientation to each side wall and each end wall of the freight container or tank. Any placards which do not relate to the contents shall be removed. Instead of using a label and a placard, it is permitted as an alternative to use enlarged labels only, as shown in Figs 2, 3 and 4, with dimensions of the minimum size shown in Fig. 5.
FIG. 6. Placard for separate display of the United Nations Number. The background colour of the placard shall be orange and the border and United Nations Number shall be black. The symbol "****" denotes the space in which the appropriate United Nations Number for radioactive material, as specified in Appendix I, shall be displayed.

444. Where the consignment in the freight container or tank is unpackaged LSA-I or SCO-I or where an exclusive use consignment in a freight container is packaged radioactive material comprised of a single United Nations Number commodity, the appropriate United Nations Number for the consignment (see Appendix I) shall also be displayed, in black digits not less than 65 mm high, either:

(a) in the lower half of the placard shown in Fig. 5, against the white background, or
(b) on the placard shown in Fig. 6.

When the alternative given in (b) above is used, the subsidiary placard shall be affixed immediately adjacent to the main placard, on all four sides of the freight container or tank.

Design of labels and placards

445. The labels and placards required by these Regulations shall conform to the appropriate models shown in Figs 1—6 and shall conform with the colours shown in Figs 2—6.

CONSIGNOR’S RESPONSIBILITIES

446. Compliance with the requirements of paras 421(d) and 436—444 for labelling, marking and placarding shall be the responsibility of the consignor.
Particulars of consignment

447. The consignor shall include in the transport documents with each consignment the following information, as applicable, in the order given:

(a) The proper shipping name, as specified in Appendix I;
(b) The United Nations Class Number "7";
(c) The words "RADIOACTIVE MATERIAL" unless these words are contained in the proper shipping name;
(d) The United Nations Number assigned to the material as specified in Appendix I;
(e) For LSA material, the group notation "LSA-I", "LSA-II" or "LSA-III", as appropriate;
(f) For SCO, the group notation "SCO-I" or "SCO-II", as appropriate;
(g) The name or symbol of each radionuclide;
(h) A description of the physical and chemical form of the material, or a notation that the material is special form radioactive material. A generic chemical description is acceptable for chemical form;
(i) The maximum activity of the radioactive contents during transport expressed in units of becquerels (Bq) (or curies (Ci)) with an appropriate SI prefix (see Appendix II). For fissile material, the total mass of fissile material in units of grams (g), or appropriate multiples thereof, may be used in place of activity.
(j) The category of the package, i.e. I-WHITE, II-YELLOW, III-YELLOW;
(k) The transport index (categories II-YELLOW and III-YELLOW only);
(l) All items and materials transported under the provisions for excepted packages (see paras 415–421) shall be described in the transport document as "RADIOACTIVE MATERIAL, EXCEPTED PACKAGE", and shall include the proper shipping name of the substance or article being transported from the list of United Nations Numbers (see Appendix I);
(m) For a consignment of fissile material, where all of the packages in the consignment are excepted under para. 560, the words “FISSILE EXCEPTED”;
(n) The identification mark for each competent authority approval certificate (special form radioactive material, special arrangement, package design, or shipment) applicable to the consignment;
(o) For consignments of packages in an overpack or freight container, a detailed statement of the contents of each package within the overpack or freight container and, where appropriate, of each overpack or freight container in the consignment. If packages are to be removed from the overpack or freight container at a point of intermediate unloading, appropriate transport documentation shall be made available; and
(p) Where a consignment is required to be shipped under exclusive use, the statement “EXCLUSIVE USE SHIPMENT”.

51
Notification of competent authorities

455. Before the first shipment of any package requiring competent authority approval, the consignor shall ensure that copies of each applicable competent authority certificate applying to that package design have been submitted to the competent authority of each country through or into which the consignment is to be transported. The consignor is not required to await an acknowledgement from the competent authority, nor is the competent authority required to make such acknowledgement of receipt of the certificate.

456. For each shipment listed in (a), (b) or (c) below, the consignor shall notify the competent authority of each country through or into which the consignment is to be transported. This notification shall be in the hands of each competent authority prior to the commencement of the shipment, and preferably at least 7 days in advance.

(a) Type B(U) packages containing radioactive material with an activity greater than \( 3 \times 10^3 \) \( A_1 \) or \( 3 \times 10^3 \) \( A_2 \), as appropriate, or 1000 TBq (20 kCi), whichever is the lower.
(b) Type B(M) packages.
(c) Transport under special arrangement.

457. The consignment notification shall include:

(a) Sufficient information to enable the identification of the package including all applicable certificate numbers and identification marks;
(b) Information on the date of shipment, the expected date of arrival and proposed routing;
(c) The name of the radioactive material or nuclide;
(d) A description of the physical and chemical form of the radioactive material, or whether it is special form radioactive material; and
(e) The maximum activity of the radioactive contents during transport expressed in units of becquerels (Bq) (or curies (Ci)) with an appropriate SI prefix (see Appendix II). For fissile material, the mass of fissile material in units of grams (g), or multiples thereof, may be used in place of activity.

458. The consignor is not required to send a separate notification if the required information has been included in the application for shipment approval. See para. 718.

Possession of certificates and operating instructions

459. The consignor shall have in his possession a copy of each certificate required under Section VII of these Regulations and a copy of the instructions with regard to the proper closing of the package and other preparations for shipment before making any shipment under the terms of the certificates.
TABLE XI. TI LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES

<table>
<thead>
<tr>
<th>Type of freight container or conveyance</th>
<th>Limit on total sum of transport indexes in a single freight container or aboard a conveyance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not under exclusive use</td>
</tr>
<tr>
<td></td>
<td>Non-fissile material</td>
</tr>
<tr>
<td>Freight container — Small</td>
<td>50</td>
</tr>
<tr>
<td>Freight container — Large</td>
<td>50</td>
</tr>
<tr>
<td>Vehicle</td>
<td>50</td>
</tr>
<tr>
<td>Aircraft</td>
<td></td>
</tr>
<tr>
<td>Passenger</td>
<td>50</td>
</tr>
<tr>
<td>Cargo</td>
<td>200(^d)</td>
</tr>
<tr>
<td>Inland water-way vessel</td>
<td>50</td>
</tr>
<tr>
<td>Seagoing vessel(^c)</td>
<td></td>
</tr>
<tr>
<td>1. Hold, compartment or defined deck area:</td>
<td></td>
</tr>
<tr>
<td>Packages, overpacks, small freight containers</td>
<td>50</td>
</tr>
<tr>
<td>Large freight containers</td>
<td>200(^d)</td>
</tr>
<tr>
<td>2. Total vessel:</td>
<td></td>
</tr>
<tr>
<td>Packages, etc.</td>
<td>200(^d)</td>
</tr>
<tr>
<td>Large freight containers</td>
<td>No limit(^d)</td>
</tr>
<tr>
<td>3. Special use vessel(^f)</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

\(^a\) Provided that transport is direct from the consignor to the consignee without any intermediate in-transit storage where the total TI exceeds 50.

\(^b\) In cases in which the total TI is greater than 50, the consignment shall be so handled and stowed so that it is always separated from any other package, overpack, tank or freight container carrying radioactive material by at least 6 m. The intervening space between groups may be occupied by other cargo in accordance with para. 405.

\(^c\) For seagoing vessels the requirements given in 1 and 2 shall both be fulfilled.

\(^d\) Provided that the packages, overpacks, tanks or freight containers, as applicable, are stowed so that the total sum of TI's in any individual group does not exceed 50, and that each group is handled and stowed so that the groups are separated from each other by at least 6 m.

\(^e\) Packages or overpacks carried in or on a vehicle which are in accordance with the provisions of para. 469 may be transported by vessels provided that they are not removed from the vehicle at any time while on board the vessel.

\(^f\) For special use vessels, such as those used for carriage of several irradiated fuel flasks, the maximum total sum of TI's shall be subject to multilateral approval, based upon the specific circumstances, subject to the requirements of para. 472.
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Additional requirements relating to transport by rail and by road

467. Rail and road vehicles carrying packages, overpacks, tanks or freight containers labelled with any of the labels shown in Figs 2, 3 or 4, or carrying consignments under exclusive use, shall display the placard shown in Fig. 5 on each of:

(a) The two external lateral walls in the case of a rail vehicle;
(b) The two external lateral walls and the external rear wall in the case of a road vehicle.

In the case of a vehicle without sides the placards may be affixed directly on the cargo-carrying unit provided that they are readily visible; in the case of physically large tanks or freight containers, the placards on the tanks or freight containers shall suffice. Any placards which do not relate to the contents shall be removed.

468. Where the consignment in or on the vehicle is unpackaged LSA-I or SCO-I or where an exclusive use consignment is packaged radioactive material comprised of a single United Nations Number commodity, the appropriate United Nations Number (see Appendix I) shall also be displayed, in black digits not less than 65 mm high, either:

(a) In the lower half of the placard shown in Fig. 5, against the white background, or
(b) On the placard shown in Fig. 6.

When the alternative given in (b) above is used, the subsidiary placard shall be affixed immediately adjacent to the main placard, either on the two lateral walls in the case of a rail vehicle or on the two lateral walls and the end wall in the case of a road vehicle.

469. For consignments under exclusive use, the radiation level shall not exceed:

(a) 10 mSv/h (1000 mrem/h) at any point on the external surface of any package or overpack, and may only exceed 2 mSv/h (200 mrem/h) provided that:
   (i) the vehicle is equipped with an enclosure which, during routine transport, prevents the access of unauthorized persons to the interior of the enclosure, and
   (ii) provisions are made to secure the package or overpack so that its position within the vehicle remains fixed during routine transport, and
   (iii) there are no loading or unloading operations between the beginning and end of the shipment;
(b) 2 mSv/h (200 mrem/h) at any point on the outer surfaces of the vehicle, including the upper and lower surfaces, or, in the case of an open vehicle, at any point on the vertical planes projected from the outer edges of the...
vehicle, on the upper surface of the load, and on the lower external surface of the vehicle; and
(c) 0.1 mSv/h (10 mrem/h) at any point 2 m from the vertical planes represented by the outer lateral surfaces of the vehicle, or, if the load is transported in an open vehicle, at any point 2 m from the vertical planes projected from the outer edges of the vehicle.

If the exclusive use conditions and the special additional requirements specified in subpara. 469(a) do not apply, the radiation level at any point on any external surface of a package or overpack shall not exceed 2 mSv/h (200 mrem/h) and the transport index shall not exceed 10.

470. In the case of road vehicles:
(a) No persons other than the driver and assistants shall be permitted in vehicles carrying packages, overpacks, tanks or freight containers bearing category II-YELLOW or III-YELLOW labels; and
(b) The radiation level at any normally occupied position shall not exceed 0.02 mSv/h (2 mrem/h) unless the persons occupying such positions are provided with personal monitoring devices.

Additional requirements relating to transport by vessels

471. Packages having a surface radiation level greater than 2 mSv/h (200 mrem/h), unless being carried in or on a vehicle under exclusive use in accordance with Table XI, footnote e, shall not be transported by vessel except under special arrangement.

472. The transport of consignments by means of a special use vessel which, by virtue of its design, or by reason of its being chartered, is dedicated to the purpose of carrying radioactive material, shall be excepted from the requirements specified in para. 465 provided that the following conditions are met:

(a) A radiation protection programme for the shipment shall be prepared and shall be approved by the competent authority of the flag state of the vessel and, when requested, by the competent authority at each port of call;
(b) Stowage arrangements shall be predetermined for the whole voyage including any consignments to be loaded at ports of call en route; and
(c) The loading, handling and stowage and the unloading of the consignments shall be supervised by persons qualified in the carriage of radioactive material.

Additional requirements relating to transport by air

473. Type B(M) packages and consignments under exclusive use shall not be transported on passenger aircraft.
474. Vented Type B(M) packages, packages which require external cooling by an ancillary cooling system, packages subject to operational controls during transport, and packages containing liquid pyrophoric materials shall not be transported by air.

475. Packages having a surface radiation level greater than 2 mSv/h (200 mrem/h), otherwise allowed under exclusive use transport by road or by rail, shall not be transported by air except by special arrangement.

Additional requirements relating to transport by post

476. A consignment that conforms with the requirements of para. 415, and in which the activity of the contents does not exceed one tenth of the limits prescribed in Table IV, may be accepted for domestic movement by national postal authorities, subject to such additional requirements as those authorities may prescribe.

477. A consignment that conforms with the requirements of para. 415, and in which the activity of the contents does not exceed one tenth of the limits prescribed in Table IV, may be accepted for international movement by post, subject in particular to the following additional requirements as prescribed by the Acts of the Universal Postal Union:

(a) it shall be deposited with the postal service only by consignors authorized by the national authority;
(b) it shall be dispatched by the quickest route, normally by air;
(c) it shall be plainly and durably marked on the outside with the words "RADIOACTIVE MATERIAL – Quantities permitted for Movement by Post"; these words shall be crossed out if the packaging is returned empty;
(d) it shall carry on the outside the name and address of the consignor with the request that the consignment be returned in the case of non-delivery; and
(e) the name and address of the consignor and the contents of the consignment shall be indicated on the internal packaging.

STORAGE IN TRANSIT

478. Packages, overpacks, freight containers and tanks shall be segregated during storage in transit:

(a) From places occupied by workers and members of the public and from undeveloped photographic film, for radiation exposure control purposes, in accordance with paras 205 and 206; and
(b) From other dangerous goods in accordance with para. 406.
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package shall be so designed that it can be properly secured in or on the conveyance during transport.

506. The design shall be such that any lifting attachments on the package will not fail when used in the intended manner and that, if failure of the attachments should occur, the ability of the package to meet other requirements of these Regulations would not be impaired. Assessment shall take account of appropriate safety factors to cover snatch lifting.

507. Attachments and any other features on the outer surface of the package which could be used to lift it shall be designed either to support its mass in accordance with the requirements of para. 506 or shall be removable or otherwise rendered incapable of being used during transport.

508. As far as practicable, the packaging shall be so designed and finished that the external surfaces are free from protruding features and can be easily decontaminated.

509. As far as practicable, the outer layer of the package shall be so designed as to prevent the collection and the retention of water.

510. Any features added to the package at the time of transport which are not part of the package shall not reduce its safety.

511. The package shall be capable of withstanding the effects of any acceleration, vibration or vibration resonance which may arise under conditions likely to be encountered in routine transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole. In particular, nuts, bolts, and other securing devices shall be so designed as to prevent them from becoming loose or being released unintentionally, even after repeated use.

512. The materials of the packaging and any components or structures shall be physically and chemically compatible with each other and with the radioactive contents. Account shall be taken of their behaviour under irradiation.

513. All valves through which the radioactive contents could otherwise escape shall be protected against unauthorized operation.

514. For radioactive material having other dangerous properties the package design shall take into account those properties, see paras 105 and 407.

ADDITIONAL REQUIREMENTS FOR PACKAGES TRANSPORTED BY AIR

515. For packages to be transported by air, the temperature of the accessible surfaces shall not exceed 50°C at an ambient temperature of 38°C with no account taken for insolation.
516. **Packages** to be transported by air shall be so designed that, if they were exposed to ambient temperatures ranging from \(-40^\circ C\) to \(+55^\circ C\), the integrity of containment would not be impaired.

517. **Packages** containing liquid radioactive materials to be transported by air, shall be capable of withstanding without leakage an internal pressure which produces a pressure differential of not less than 95 kPa (0.95 kgf/cm\(^2\)).

**REQUIREMENTS FOR INDUSTRIAL PACKAGES**

**Requirements for industrial package Type 1 (IP-1)**

518. An industrial package Type 1 (IP-1) shall be designed to meet the requirements specified in paras 505–514 and 525, and, in addition, the requirements of paras 515–517 if carried by air.

**Additional requirements for industrial package Type 2 (IP-2)**

519. A package, to be qualified as an industrial package Type 2 (IP-2), shall be designed to meet the requirements for IP-1 as specified in para. 518 and, in addition, if it were subjected to the tests specified in paras 622 and 623, or, alternatively to the tests specified for packaging group III in the “Recommendations on the Transport of Dangerous Goods”, prepared by the United Nations Committee of Experts on the Transport of Dangerous Goods, it would prevent:

(a) The loss or dispersal of the radioactive contents; and
(b) The loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of the package.

**Additional requirements for industrial package Type 3 (IP-3)**

520. A package, to be qualified as an industrial package Type 3 (IP-3), shall be designed to meet the requirements for IP-1 as specified in para. 518 and, in addition, the requirements specified in paras 525–538.

**Alternative requirements for tanks and freight containers to qualify as IP-2 and IP-3**

521. Tank containers may also be used as industrial package Types 2 and 3, (IP-2) and (IP-3) provided that:

(a) They shall satisfy the requirements for IP-1 specified in para. 518;
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539. A Type A package designed to contain liquids shall, in addition:

(a) Be adequate to meet the conditions specified in para. 537 above if the package is subjected to the tests specified in para. 625; and

(b) Either

(i) be provided with sufficient absorbent material to absorb twice the volume of the liquid contents. Such absorbent material must be suitably positioned so as to contact the liquid in the event of leakage; or

(ii) be provided with a containment system composed of primary inner and secondary outer containment components designed to ensure retention of the liquid contents, within the secondary outer containment components, even if the primary inner components leak.

However, the requirements given in subpara. 539(b) shall not apply in the case of a Type B package designed and approved for liquids which contains the same liquids having an activity equal to or less than the $A_2$ limit for the authorized contents.

540. A package designed for compressed gases or uncompressed gases shall prevent loss or dispersal of the radioactive contents if the package were subjected to the tests specified in para. 625. A package designed for contents not exceeding 40 TBq (1000 Ci) of tritium or for noble gases in gaseous form with contents not exceeding $A_2$ shall be excepted from this requirement.

REQUIREMENTS FOR TYPE B PACKAGES

541. Type B packages shall be designed to meet the requirements specified in paras 505—514, the requirements of paras 515—517 if carried by air, and of paras 525—538, except as specified in para. 548(a), and, in addition, the requirements specified in paras 542—548 and either paras 550—556 or paras 557 and 558, as applicable.

542. A package shall be so designed that, if it were subjected to the tests in paras 626—629, it would retain sufficient shielding to ensure that the radiation level at 1 m from the surface of the package would not exceed 10 mSv/h (1 rem/h) with the maximum radioactive contents which the package is designed to carry.

543. A package shall be so designed that, under the ambient conditions specified in paras 545 and 546, heat generated within the package by the radioactive contents shall not, under normal conditions of transport, as demon-
554. A package shall not have a maximum normal operating pressure in excess of a gauge pressure of 700 kPa (7 kgf/cm²).

555. Except as required in para. 515 for a package transported by air, the maximum temperature of any surface readily accessible during transport of a package shall not exceed 85°C in the absence of insolation under the ambient condition specified in para. 545; and the package shall be carried under exclusive use, as specified in para. 544, if this maximum temperature exceeds 50°C. Account may be taken of barriers or screens intended to give protection to transport workers without the need for the barriers or screens being subject to any test.

556. A package shall be designed for an ambient temperature range from -40°C to +38°C.

Requirements for Type B(M) packages

557. Type B(M) packages shall meet the requirements for Type B packages specified in paras 541–548, except that for packages to be transported solely within a specified country or solely between specified countries, conditions other than those given in paras 545, 546 and 556 above may be assumed with the approval of the competent authorities of these countries. As far as practicable, the requirements for Type B(U) packages specified in paras 550–556 shall be met.

558. Intermittent venting of Type B(M) packages may be permitted during transport, provided that the operational controls for venting are acceptable to the relevant competent authorities.

REQUIREMENTS FOR PACKAGES CONTAINING FISSILE MATERIAL

559. Except as provided in para. 560, packages containing fissile material shall be so designed, and used, to comply with the requirements specified in paras 561–568, as well as those specified in paras 518–520, 524 or 541, as applicable, taking into account the nature, activity and form of the contents.

560. Packages meeting one of the requirements of subparas 560(a)–560(f) shall be excepted from the requirements specified in paras 561–568, and from the other requirements of these Regulations that apply specifically to fissile material; such packages, however, shall be regulated as non-fissile radioactive material packages as applicable, and shall still be subject to those requirements of these Regulations which pertain to their radioactive nature and properties.

(a) Packages containing individually not more than 15 g of fissile material, provided that the smallest external dimension of each package is not less than 10 cm. For unpackaged material, the quantity limitation shall apply to the consignment being carried in or on the conveyance.
TABLE XIV. FREE DROP DISTANCE FOR TESTING PACKAGES TO NORMAL CONDITIONS OF TRANSPORT

<table>
<thead>
<tr>
<th>Package mass (kg)</th>
<th>Free drop distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>package mass &lt; 5000</td>
<td>1.2</td>
</tr>
<tr>
<td>5000 &lt; package mass &lt; 10000</td>
<td>0.9</td>
</tr>
<tr>
<td>10000 &lt; package mass &lt; 15000</td>
<td>0.6</td>
</tr>
<tr>
<td>15000 &lt; package mass</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Tests for demonstrating ability to withstand normal conditions of transport

619. The tests are: the water spray test, the free drop test, the stacking test, and the penetration test. Specimens of the package shall be subjected to the free drop test, the stacking test and the penetration test, preceded in each case by the water spray test. One specimen may be used for all the tests, provided that the requirements of para. 620 are fulfilled.

620. The time interval between the conclusion of the water spray test and the succeeding test shall be such that the water has soaked in to the maximum extent, without appreciable drying of the exterior of the specimen. In the absence of any evidence to the contrary, this interval shall be taken to be two hours if the water spray is applied from four directions simultaneously. No time interval shall elapse, however, if the water spray is applied from each of the four directions consecutively.

621. Water spray test. The specimen shall be subjected to a water spray test that simulates exposure to rainfall of approximately 5 cm per hour for at least one hour.

622. Free drop test. The specimen shall drop onto the target so as to suffer maximum damage in respect of the safety features to be tested.

(a) The height of drop measured from the lowest point of the specimen to the upper surface of the target shall be not less than the distance specified in Table XIV for the applicable mass. The target shall be as defined in para. 618.
SECTION VII

APPROVAL AND ADMINISTRATIVE REQUIREMENTS

GENERAL

701. Competent authority approval shall be required for the following:

(a) Special form radioactive material (see paras 702 and 703).
(b) All packages containing fissile material (see paras 710—712, 713 and 714).
(c) Type B packages — Type B(U) and Type B(M) (see paras 704—709, 713 and 714).
(d) Special arrangements (see paras 720—722).
(e) Certain shipments (see paras 716—719).
(f) Radiation protection programme for special use vessels (see para. 472), and
(g) Calculation of unlisted $A_1$ and $A_2$ values (see para. 302).

APPROVAL OF SPECIAL FORM RADIOACTIVE MATERIAL

702. The design for special form radioactive material shall require unilateral approval. An application for approval shall include:

(a) A detailed description of the radioactive material or, if a capsule, the contents; particular reference shall be made to both physical and chemical states;
(b) A detailed statement of the design of any capsule to be used;
(c) A statement of the tests which have been done and their results, or evidence based on calculative methods to show that the radioactive material is capable of meeting the performance standards, or other evidence that the special form radioactive material meets the applicable requirements of the Regulations and
(d) Evidence of a quality assurance programme.

703. The competent authority shall establish an approval certificate stating that the approved design meets the requirements for special form radioactive material and shall attribute to that design an identification mark. The certificate shall specify the details of the special form radioactive material.

APPROVAL OF PACKAGE DESIGNS

Approval of Type B(U) package designs

704. Each Type B(U) package design shall require unilateral approval, except that a package design for fissile material, which is also subject to paras 710—712, shall require multilateral approval.
705. An application for approval shall include:

(a) A detailed description of the proposed radioactive contents with particular reference to their physical and chemical states and the nature of the radiation emitted;
(b) A detailed statement of the design; including complete engineering drawings and schedules of materials and methods of construction to be used;
(c) A statement of the tests which have been done and their results, or evidence based on calculative methods or other evidence that the design is adequate to meet the applicable requirements;
(d) The proposed operating and maintenance instructions for the use of the packaging;
(e) If the package is designed to have a maximum normal operating pressure in excess of 100 kPa (1.0 kgf/cm²) gauge, the application for approval shall, in particular, state, in respect of the materials of construction of the containment system, the specifications, the samples to be taken, and the tests to be made;
(f) Where the proposed radioactive contents are irradiated fuel, the applicant shall state and justify any assumption in the safety analysis relating to the characteristics of the fuel;
(g) Any special stowage provisions necessary to ensure the safe dissipation of heat from the package; consideration shall be given to the various modes of transport to be used and type of conveyance or freight container;
(h) A reproducible illustration not larger than 21 cm by 30 cm showing the make-up of the package; and
(i) Evidence of a quality assurance programme.

706. The competent authority shall establish an approval certificate stating that the design meets the requirements for Type B(U) packages.

Approval of Type B(M) package designs

707. Each Type B(M) package design, including those for fissile material which are also subject to paras 710–712, shall require multilateral approval.

708. An application for approval of a Type B(M) package design shall include, in addition to the information required in para. 705 for Type B(U) packages:

(a) A list of the specific requirements for Type B(U) packages specified in para. 549 with which the package does not conform;
(b) Any proposed supplementary operational controls to be applied during transport not routinely provided for in these Regulations, but which are necessary to ensure the safety of the package or to compensate for the deficiencies listed in (a) above, such as human intervention for temperature or pressure measurements or for periodic venting, taking into account the possibility of unexpected delay;
(c) A statement relative to any restrictions on the mode of transport and to any special loading, carriage, unloading or handling procedures; and
(d) The maximum and minimum ambient conditions (temperature, solar radiation) expected to be encountered during transport and which have been taken into account in the design.

709. The **competent authority** shall establish an approval certificate stating that the **design** meets the applicable requirements for **Type B(M) packages**.

**Approval of package designs for fissile material**

710. Each **package design** for fissile material shall require multilateral approval.

711. An application for approval shall include all information necessary to satisfy the **competent authority** that the **design** meets the requirements of paras 561—568, and evidence of a quality assurance programme.

712. The **competent authority** shall establish an approval certificate stating that the **design** meets the requirements of paras 561—568.

**Approvals under the 1967, 1973 and the 1973 (As Amended) Editions of the Regulations**

713. **Packagings** manufactured to a **design** approved by the **competent authority** under the provisions of the 1967 Edition of these Regulations may continue to be used, subject to multilateral approval. Changes in the **design** of the **packaging** or in the nature or quantity of the authorized **radioactive contents** which, as determined by the **competent authority**, would significantly affect safety shall be required to meet the 1985 Edition of the Regulations. No new construction of such **packagings** shall be permitted to commence. A serial number according to the provision of para. 438 shall be assigned to and marked on the outside of each **packaging**.

714. **Packagings** manufactured to a **design** approved under the provisions of the 1973 Edition and the 1973 (As Amended) Edition of these Regulations may continue to be used until 31 December 1992.

    After this date:

(a) Multilateral approval shall be required; and
(b) A serial number, according to the provisions of para. 438, shall be assigned to and marked on the outside of each **packaging**.

Changes in the **design** of the **packaging** or in the nature or quantity of the authorized **radioactive contents** which, as determined by the **competent authority**, would significantly affect safety shall be required to meet the 1985 Edition of the Regulations. Each Member State shall require that all **packagings** for which

NOTIFICATION AND REGISTRATION OF SERIAL NUMBERS

715. The competent authority shall be informed of the serial number of each packaging manufactured to a design approved under paras 704, 707, 710, 713 and 714. The competent authority shall maintain a register of such serial numbers.

APPROVAL OF SHIPMENTS

716. Except as allowed in para. 717, multilateral approval shall be required for:

(a) The shipment of Type B(M) packages especially designed to allow controlled intermittent venting;
(b) The shipment of Type B(M) packages containing radioactive material with an activity greater than $3 \times 10^3 A_1$ or $3 \times 10^3 A_2$, as appropriate, or 1000 TBq (20 kCi), whichever is the lower;
(c) The shipment of packages containing fissile materials if the sum of the transport indexes of the individual packages exceeds 50 as provided in para. 465; and
(d) Radiation protection programmes for shipments by special use vessels according to para. 472.

717. A competent authority may authorize transport into or through its country without shipment approval, by a specific provision in its design approval (see para. 723).

718. An application for shipment approval shall include:

(a) The period of time, related to the shipment, for which the approval is sought;
(b) The actual radioactive contents, the expected modes of transport, the type of conveyance, and the probable or proposed route; and
(c) The details of how the special precautions and special administrative or operational controls, referred to in the package design approval certificates issued under paras 706, 709 and 712, are to be put into effect.

719. Upon approval of the shipment, the competent authority shall issue an approval certificate.

APPROVAL OF SHIPMENT UNDER SPECIAL ARRANGEMENT

720. Each consignment shipped under special arrangement shall require multilateral approval.
(c) The revision of a certificate shall be indicated by a parenthetical expression following the identification mark on the certificate. For example, A/132/B(M)F-85(Rev. 2) would indicate revision 2 of the Austrian package design approval certificate; or A/132/B(M)F-85(Rev.0) would indicate the original issuance of the Austrian package design approval certificate. For original issuances, the parenthetical entry is optional and other words such as 'original issuance' may also be used in place of 'Rev.0'. Certificate revision numbers may only be issued by the country issuing the original approval certificate.

(d) Additional symbols (as may be necessitated by national requirements) may be added in brackets to the end of the identification mark; for example, A/132/B(M)F-85(SP503).

(e) It is not necessary to alter the identification mark on the packaging each time that a revision to the design certificate is made. Such re-marking shall be made only in those cases where the revision to the package design certificate involves a change in the letter type codes for the package design following the second stroke.

CONTENTS OF APPROVAL CERTIFICATES

Special form radioactive material approval certificates

726. Each approval certificate issued by a competent authority for special form radioactive material shall include the following information:

(a) Type of certificate.
(b) The competent authority identification mark.
(c) The issue date and an expiry date.
(d) List of applicable national and international regulations, including the edition of the IAEA Regulations for the Safe Transport of Radioactive Materials under which the special form radioactive material is approved.
(e) The identification of the special form radioactive material.
(f) A description of the special form radioactive material.
(g) Design specifications for the special form radioactive material which may include references to drawings.
(h) A specification of the radioactive contents which includes the activities involved and which may include the physical and chemical form.
(i) A specification of the applicable quality assurance programme as required in para. 209.
(j) If deemed appropriate by the competent authority, reference to the identity of the applicant.
(k) Signature and identification of the certifying official.
consignment, including any special stowage provisions for the safe dissipation of heat.

(m) If deemed appropriate by the competent authority, reasons for the special arrangement.

(n) Description of the compensatory measures to be applied as a result of the shipment being under special arrangement.

(o) Reference to information provided by the applicant relating to the use of the packaging or specific actions to be taken prior to the shipment.

(p) A statement regarding the ambient conditions assumed for purposes of design if these are not in accordance with those specified in paras 545, 546 and 556, as applicable.

(q) Any emergency arrangements deemed necessary by the competent authority.

(r) A specification of the applicable quality assurance programme as required in para. 209.

(s) If deemed appropriate by the competent authority, reference to the identity of the applicant and to the identity of the carrier.

(t) Signature and identification of the certifying official.

Shipment approval certificates

728. Each approval certificate for a shipment issued by a competent authority shall include the following information:

(a) Type of certificate.

(b) The competent authority identification mark.

(c) The issue date and an expiry date.

(d) List of applicable national and international regulations, including the edition of the IAEA Regulations for the Safe Transport of Radioactive Materials under which the shipment is approved.

(e) Any restrictions on the modes of transport, type of conveyance, freight container, and any necessary routing instructions.

(f) The following statement:

“This certificate does not relieve the consignor from compliance with any requirement of the government of any country through or into which the package will be transported.”

(g) A detailed listing of any supplementary operational controls required for preparation, loading, transport, stowage, unloading, and handling of the consignment, including any special stowage provisions for the safe dissipation of heat.

(h) Reference to information provided by the applicant relating to specific actions to be taken prior to shipment.

(i) Reference to the applicable design approval certificate.

(j) A brief specification of the actual radioactive contents, including any restrictions on the radioactive contents which might not be obvious from
the nature of the packaging. This shall include the physical and chemical forms, the total activities involved (including those of the various isotopes, if appropriate), amounts in grams (for fissile material), and whether special form radioactive material.

(k) Any emergency arrangements deemed necessary by the competent authority.

(l) A specification of the applicable quality assurance programme as required in para. 209.

(m) If deemed appropriate by the competent authority, reference to the identity of the applicant.

(n) Signature and identification of the certifying official.

Package design approval certificates

729. Each approval certificate of the design of a package issued by a competent authority shall include the following information:

(a) Type of certificate.

(b) The competent authority identification mark.

(c) The issue date and an expiry date.

(d) Any restriction on the modes of transport, if appropriate.

(e) List of applicable national and international regulations, including the edition of the IAEA Regulations for the Safe Transport of Radioactive Materials under which the design is approved.

(f) The following statement:

“This certificate does not relieve the consignor from compliance with any requirement of the government of any country through or into which the package will be transported.”

(g) References to certificates for alternative radioactive contents, other competent authority validation, or additional technical data or information, as deemed appropriate by the competent authority.

(h) A statement authorizing shipment where shipment approval is required under para. 716, if deemed appropriate.

(i) Identification of the packaging.

(j) Description of the packaging by a reference to the drawings or specification of the design. If deemed appropriate by the competent authority, a reproducible illustration not larger than 21 cm by 30 cm showing the make-up of the package should also be provided, accompanied by a very brief description of the packaging including materials of construction, gross mass, general outside dimensions, and appearance.

(k) Specification of the design by reference to the drawings.

(l) A brief specification of the authorized radioactive content, including any restrictions on the radioactive contents which might not be obvious from the nature of the packaging. This shall include the physical and chemical forms, the activities involved (including those of the various isotopes, if
Fissile (See also Criticality): 129, 131(a)(iii), Section III, 314–315, 401(b)&(c), 402(b), 415(c), 423, Table VIII, 431, 442(b), 447(i)&(m), 457(e), 464, Table XI, 482, 559–568, Table XIII, 617(c), 622(b), 631–633, 701(b), 704, 707, 710–712, 716(c), 724(c), 725(a), 727(j)&(k), 728(j), 729(l)&(m)

Freight Container: 128, 130, 133–135, 146, 409, Table III, 424, 428, Table VIII, Table X, 440–444, 447(o), 453(a), 460, 465, Table XI, 467, 470(a), 478, 479, 480, 521–523, 705(g), 727(e), 728(e)

G

Gas: 131(b), 138, 145, 147, Table IV, Table V, Table VI, 522, 533, 540, 625
Group: 131, 144, 205(b), 305, 425, 442(a)(ii), 447(e)&(f), Table XI(b)&(d), 479, 480, 519

H

Heat: 401(b), 453(a), 463, 503(b), 543, 604, 610, 628, 705(g), 727(l), 728(g), 729(o)

I

Identification Mark: 438(a), 447(n), 457(a), 703, 724–725, 726(b), 727(b), 728(b), 729(b)
Industrial Package: 134(b), 311, Table V, 518–523, 724(c), 725(a)
Industrial Type Packages: (See Industrial Package)
Information for Carriers: 453–454
Insolation (solar radiation): 515, 546, Table XII, 555
Inspection: 107, 136, 209, 210, 401–402

L

Label: 421(d), 440–443, 445, Figs 2–4, 452, 467, 470(a)
Leaching: 131(c), 503(c), 606, 612–613
Leakage (Loss): 410, 503(c), 517, 535, 539(b), 565, 606, 612–613, 631–633
Low Specific Activity (LSA): 131, 134(b), 146, Table I, 311, 403, 414, 422–427, Table V, Table VI, 428, Table VIII, 442(a), 444, 447(e), 465(a), 468, 481, 501, 522, 601(a), 603

M

Maintenance: 103, 209, 210, 565(a), 705(d)
Marking: 407, 418(b), 419(b), 436–439, 446, 725(a)
Mass: 143, 150, 315(a), 436, 442(b), 447(i), 457(e), 505, 507, 548(b), 560, Table XIII, 568(c), 622, Table XIV, 623(a), 624(a), 627(c), 727(i), 729(j)
Maximum Normal Operating Pressure: 132, 553, 554, 705(e)
Multilateral: 113, 141, 211, 302, 466(f), 565(b), 704, 707, 710, 713, 714(a), 716, 720, 725(a)&(b), 730

109
N
Normal Conditions: 103, 134, 411, 521(c), 527, 543, 555, 562, 619–624, Table XIV
Notification: 113, 455–458, 715
Number “N”: 429, 567

O
Operational Controls: 132, 474, 558, 708(b), 718(c), 721(b), 727(l), 728(g), 729(o)
Other Dangerous Properties: 105, 407, 440, 514
Overpack: 130, 133, 146, 409, Table III, 428, Table VIII, 431, 432–434, 435, Table X, 440, 441, 442(c), 447(o), 453(a), 460, 461, 463, 465, 466, Table XI, 467, 469, 470(a), 478, 479, 480

P
Package Design: 209, 313, 315, 437, 438(c), 439, 447(n), 455, 704–714, 718(c), 723, 724(c)&(d), 725(a), (c)&(e), 727(k), 729
Package — Excepted: 134(a), 308–310, Table III, 415–420, Table IV, 421, 443, 447(l), 452
Package — Industrial: 134(b), 311, Table V, 518–523, 724(c), 725(a)
Package — Type A: 110, 134(c), 312, 437, 524–540, 625, 724(c)
Package — Type B: 134(d), 313, 401(b), 402, 539, 541–548, 549, 557, 701(c)
Package — Type B(U): 438(c), 439, 456(a), 549–556, 557, 701(c), 704–706, 708, 724(c)
Package — Type B(M): 438(c), 439, 456(b), 473, 474, 557–558, 701(c), 707–709, 716(a)&(b), 724(c), 725(a), 729(n)
Packaging: 103, 107, 121, 127, 130, 131(c), 134, 135, 138, 209, 210, 314, 315, 401(b), 401(c), 402(b), 403, 415(b), 421, 426, 436, 437, 438, 438(b), 452, 477(c)&(e), Section V, 505–514, 519, 528, 532, 536, 539, 543(b), 563, 565(a), 566(a), 601(a), 617(b), 623, 705, 713, 714, 715, 725(e), 727(i), (j)&(o), 728(j), 729(i),(j),(l)&(p)
Placard: 407, 443–445, 446, Figs 5 & 6, 467, 468
Placarding (See Placard)
Post: 310, 415(d), 476, 477
Pressure: 132, 147, 401(a), 402(c), 517, 521(b), 530, 534, 535, 552, 553, 554, 629, 630, 705(e), 708(b)
Pressure Relief: 535, 552

Q
Quality Assurance: 107, 136, 209, 702(d), 705(i), 711, 726(i), 727(r), 728(l), 729(r)

R
Radiation — Control: 428, Table VIII, 460(a), 478(a), 483
Radiation — Dose Equivalent: 137
This publication is no longer valid
Please see http://www-ns.iaeao.org/standards/
Tie-down: 145, 527

Transport: 101–107, 115, 119, 120, 121, 125, 130, 132, 134, 136, 146, 202, 203, 205, 206, 207, 209, 211, 302, 310, 403–406, 407, 408, 411, 414, 415–420, 421, 422–427, 431, 442(b), 447(i), 448, 449, 453(a)&(b), 456(c), 457(e), 460–477, Table XI(a), 505, 507, 510, 511, 519, 521(b)&(c), 543, 547, 555, 558, 560(d), 562, 564(a), 568, 601(a), 619–624, Table XIV, 626–629, 705(g), 708(b),(c)&(d), 717, 718(b), 721, 726(d), 727(d),(e),(f)&(l), 728(d),(e)&(g), 729(d),(e)&(o)

Transport Documents: 120, 442(c), 447, 448, 453

Transport Index (TI): 146, 428–431, Table VIII, 432, 435(a), 439–442, 447(k), 464, 465(a), 466, Table XI, 469, 479, 480, 482, 716(c), 727(k), 729(m)

Transport Workers: 201–205, 555

U

Ullage: 538

Uncompressed Gas: 147, 540

Unilateral: 114, 402(c), 702, 704

UN Numbers: 444, Figs 5&6, 447(b),(d)&(l), 468, Appendix I

Unpackaged: 130, 146, 418(a), 425, 426, Table V(a), 428, Table VIII, 444, 468, 560(a)&(b)

V

Vehicle: 125(a), 126, 145, 151, Table XI, 467–470, 471, 724(a)

Venting: 132, 558, 708(b), 716(a)

Vessel: 125(b), 126, 152, 433, Table XI, 471, 472, 701(f), 716(d), 67

Vessel (transport by): 125(b), 152, 433, 471, 472

W

Water: 102, 105, 125(b), 131, 208, Table VI, 439, 501, 503(c), 509, 550, 562(a)&(e), 563(b), 565, 566(a)&(b), 567, 603, 612(a),(b),(c)&(e), 613(a), 619–621, 626, 629–633, 727(k), 729(m)

White Label: (See Categories)

Y

Yellow Label: (See Categories)
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Modifications are marked with a vertical line in the right margin of the text for easy location.
## CONTENTS

### SECTION I. INTRODUCTION
- Definitions for the purpose of the Regulations

### SECTION II. GENERAL PROVISIONS
- Radiation protection
- Emergency response
- Quality assurance
- Compliance assurance
- Special arrangement

### SECTION III. ACTIVITY AND FISSION MATERIAL LIMITS
- Basic $A_1/A_2$ values
- Determination of $A_1$ and $A_2$
- Contents limits for packages

### SECTION IV. PREPARATION, REQUIREMENTS AND CONTROLS
   FOR SHIPMENT AND FOR STORAGE IN TRANSIT
- Package inspection requirements
- Transport of other goods
- Other dangerous properties of contents
- Requirements and controls for contamination and for leaking packages
- Requirements and controls for transport of excepted packages
- Requirements and controls for transport of LSA material and
  SCO in industrial packages or unpackaged
- Requirements and controls for transport of LSA and SCO
- Determination of transport index (TI)
- Limits on transport index and radiation level for packages and overpacks
- Categories
- Marking, labelling and placarding
- Consignor’s responsibilities
- Transport
- Storage in transit
- Customs operations
country. Consequently, only approval by the competent authority of the country of origin of the design is required.

Contamination

E-122.1. Radioactive contamination may give rise to exposure of persons through the following pathways:

— external irradiation
— inhalation of airborne radioactive material
— ingestion of radioactive material, either directly or indirectly.

E-122.2. Below levels of 0.4 Bq/cm² (10⁻⁵ μCi/cm²) for beta and gamma emitters and for low toxicity alpha emitters (see also para. E-408.2), or 0.04 Bq/cm² (10⁻⁶ μCi/cm²) for all other alpha emitters, contamination, through any of these pathways, can only give rise to insignificant exposure.

E-123. Fixed contamination can only give rise to exposure through external irradiation.

E-124. Non-fixed contamination can give rise to exposure through any or all of the various pathways.

Exclusive use

E-128.1. The special features of an ‘exclusive use’ shipment are, by definition, first that a single consignor must make the shipment and, through arrangements with the carrier, must have sole use of the conveyance (or large freight container with a minimum length of 6 m); and second, that all initial, intermediate and final loading and unloading of the consignment are carried out only in strict accordance with directions from the consignor or consignee. The 6 m minimum length is a practical consideration in that a 6 m freight container is the smallest now considered as being equivalent to a separate conveyance.

E-128.2. Since ordinary in-transit handling of the consignment under exclusive use will not occur, some of the requirements which apply to normal shipments can be relaxed. In view of the additional control which is exercised over exclusive use consignments, specific provisions have been made for them which allow:

— use of a lower integrity industrial package type for LSA materials;
— shipment of packages with radiation levels exceeding 2 mSv/h (200 mrem/h) at the surface or a transport index exceeding 10; and
— increase by a factor of two in the total number of transport indexes for fissile material packages in a number of cases.
classified as SCO-II, such objects require the higher standard of containment afforded by industrial packaging IP-2.

E-144.2. The SCO-I model used as justification for the limit for fixed contamination of $10^4$ times the non-fixed contamination limits is based on the following scenario. Objects thought to be included in this category are those parts of nuclear reactors or other fuel cycle machinery which have come in contact with primary or secondary coolant or process waste which has contaminated their surface with mixed fission products. Allowable fixed contamination is $4 \times 10^4$ Bq/cm$^2$ ($1 \mu$Ci/cm$^2$). A large object with a surface area of 100 m$^2$ would contain a total activity of up to $4 \times 10^{10}$ Bq ($1$ Ci). During routine transport this object can be shipped unpackaged in exclusive use transport, but a special tie-down restriction is required to ensure that the SCO-I object cannot move in such a way that the fixed contamination is scraped from its surface, and so as to avoid other cargo scraping against the SCO-I object. In an accident, the tie-down would be broken and 20% of the surface of the SCO-I object would be scraped by other packages or objects or through its own movement. From the area scraped, 20% of the fixed contamination would be freed, allowing a total radioactivity to be available for damage to persons of 1.6 GBq ($40$ mCi) of mixed fission products. It was considered that an accident severe enough to cause a tie-down device to fail would be more severe than one that causes failure of a Type A package, so that instead of having $10^{-3}$ of the scraped radionuclides of the SCO-I solid object taken into the body of a person in the vicinity of the accident, live persons would be further away and would take up only $10^{-5}$ of the available material. This would provide a level of safety equivalent to that offered by the Type A package concept.

E-144.3. The model for the SCO-II solid object is parallel to that for SCO-I, except that there may be 20 times as much fixed surface contamination. A strong industrial package is required for the SCO-II case, which was thought sufficient to reduce the amount of contamination scraped from the surface from 20% to 1%, thereby preserving the total availability of radionuclides and, as a result, providing a level of safety equivalent to that offered by the Type A package concept. The presence of 10 times more non-fixed contamination within the strong industrial package has little effect on this model.

E-144.4. See paras E-131.1 and E-131.2.

Tank

E-145.1. The lower capacity limit of 450 litres (1000 litres in the case of gases) is included to achieve harmonization with Chapter 12 of the United Nations Recommendations [1].

E-145.2. In the 1988 Supplement, para. 145 is modified to include solid contents in tanks where such contents are placed in the tank in liquid or gaseous form and subsequently solidified prior to transport (for example, UF$_6$).
E-201.1. The general principles for radiation protection are based on the recommendations of the International Commission on Radiological Protection (ICRP) [2] and are consistent with the Agency’s Basic Safety Standards for Radiation Protection, Safety Series No. 9 [3]. In recent years major reviews have been performed of the basic standards for radiation protection. The 1985 Edition of the Regulations takes account of these recently promulgated international standards.

E-201.2. The system of dose limitation is summarized as follows:

— no practice shall be adopted unless its introduction produces a positive net benefit (justification of the practice);
— all exposures shall be kept as low as reasonably achievable, economic and social factors being taken into account (optimization of radiation protection); and
— the dose to individuals shall not exceed the limits for the appropriate circumstances.

The dose limits are introduced as limiting conditions constraining the justification and optimization procedures, rather than permissible values to be used without optimization for the purposes of planning and design. A summary of dose equivalent limits is given in Table E-I.

E-201.3. In practical radiological protection there is a need to provide standards associated with quantities other than the basic dose equivalent limits. Standards of this type are normally known as secondary or derived limits. When such limits are related to the primary limits of dose equivalent by a defined model, they are referred to as derived limits (DLs).

E-201.4. Examples of DLs in the Regulations include the maximum activity limits $A_1$ and $A_2$, maximum levels for non-fixed contamination, radiation levels at the surfaces of packages and in their proximity, and segregation distances associated with the transport index. The Regulations stress the importance of assessment and measurement to ensure that standards are being complied with.

E-202. In the past, practical radiological protection was concerned mainly with ensuring compliance with 'dose limits' with less regard being paid to the other principles. In the currently recommended system of dose limitation more emphasis is placed on justification of a practice and optimization of radiation protection.
any one activity. Therefore, the dose level of 5 mSv (500 mrem), which is 10% of
the limit for all activities, is defined as a limiting value for transport workers for the
purposes of calculating segregation distances or dose rates in regularly occupied
areas.

E-205.3. Similar arguments to those set forth in para. E-205.2 were also considered
in connection with the limiting dose level for members of the public, and accordingly
an annual dose limit of 1 mSv (100 mrem) is required to be applied to them (see
para. 205(b)). It should also be noted that the ICRP has recommended the value of
1 mSv a year as a principal limit for members of the public (Statement from the 1985
Paris meeting of ICRP).

Provision for avoiding radiation damage to film

E-206.1. Fast X-ray films, when exposed to doses exceeding 0.15 mSv (15 mrem)
of gamma radiation, may show slight fogging after development. This could interfere
with the proper use of the film and provide incorrect diagnostic interpretation. Other
types of film are also susceptible to fogging although the doses required are much
higher. Since it would be impracticable to introduce segregation procedures which
varied with the type of film, the provisions of the Regulations are designed to restrict
the exposure of undeveloped films of all kinds to a level not more than 0.1 mSv
(10 mrem) during any journey from consignor to consignee.

E-206.2. It is recognized that the use of mSv (mrem), when applied to film, is
technically incorrect; however, it has been used in this case to employ the same unit
for radiation exposure for protecting persons and film.

EMERGENCY RESPONSE

E-207. The standards prescribed by the Regulations, when complied with by
package designer, consignor, carrier and consignee ensure a very high level of safety
for the transport of radioactive material. However, accidents involving such
packages may happen. Paragraph 207 recognizes that advance planning and prepara-
tion are required to provide a sufficient and safe response to such accidents. The
response, in most cases, will be similar to the response to radiation accidents at fixed
site facilities. Thus, it is required that relevant national or international organizations
establish emergency procedures, and that in the event of a transport accident
involving radioactive materials, these procedures be followed.

E-208. The radioactive hazard may not be the only potential hazard posed by the
contents of a package of radioactive material. Other hazards may exist, including
pyrophoricity, corrosivity or oxidizing properties; or, if released, the contents may
react with the environment (air, water, etc.) in turn producing hazardous substances. It is this latter phenomenon which para. 208 addresses so as to ensure proper safety from chemical (i.e. non-radioactive) hazards, and specific attention is drawn to uranium hexafluoride (UF₆) because of its propensity to react, under certain conditions, both with humidity in the air and with water to form hydrogen fluoride and uranyl fluoride (HF and UO₂F₂).

QUALITY ASSURANCE

E-209.1. In most instances, the transport of radioactive materials involves a number of different people carrying out a variety of different activities and utilizing a wide range of equipment. Since safety in transport depends primarily on package integrity, it also (directly or indirectly) depends upon these people, the quality of their actions, the equipment they use and the way each performs.

E-209.2. For the first time quality assurance requirements have been prescribed specifically in the Regulations. It is becoming increasingly necessary to formalize quality assurance procedures and programmes and particularly necessary to harmonize international standards of quality assurance so that compliance with regulatory requirements can be achieved and adequately demonstrated.

E-209.3. Any systematic evaluation and documentation of performance judged against regulatory requirements is a form of quality assurance. A disciplined approach to all activities affecting quality, including, where appropriate, verification of satisfactory performance and/or implementation of appropriate corrective actions, provides evidence that the required quality has been achieved.

E-209.4. The Regulations do not prescribe detailed quality assurance programmes because of the wide diversity of operational needs and the somewhat differing requirements of the competent authorities of each Member State. However, a framework within which all quality assurance programmes may be based is provided. The degree of detail and depth of examination to be implemented as part of the quality assurance programme, whether in design, testing, safety analysis or administrative arrangements, are dependent on the potential hazards of individual transport operations.

E-209.5. The probability of non-compliance with regulatory requirements may be reduced or eliminated by the disciplined development and implementation of quality assurance programmes.

COMPLIANCE ASSURANCE

E-210.1. As used in the Regulations, the term ‘compliance assurance’ has a very broad meaning which includes all of the measures applied by a competent authority
E-210.6. An essential part of any compliance assurance programme is a system for enforcement of regulatory compliance with overall goals, essentially:

— to foster compliance by the users of the Regulations,
— to obtain corrective action on non-compliance by the user,
— to deter future non-compliance, and
— to encourage improvement in users' programmes.

The primary purpose of an enforcement programme is not to carry out punitive action, but to foster compliance with the Regulations.

E-210.7. Since the Regulations include requirements for emergency provisions during the transport of radioactive materials (see para. 207), a compliance assurance programme should include activities pertaining to emergency planning and preparedness and to emergency response when needed. These activities should be incorporated into the appropriate national emergency plans. The appropriate competent authority should also ensure that consignors and carriers have adequate emergency plans.

E-210.8. A compliance assurance programme is effectively implemented if its scope and objectives are conveyed to all parties involved in the transport of radioactive materials, i.e. designers, manufacturers, consignors and carriers. Therefore compliance assurance programmes should include provisions for information dissemination and for ensuring that adequate training occurs. The major aims to be achieved by such programmes are:

— to inform users about the way the competent authority expects them to comply with the Regulations;
— to inform users in a timely way about new developments in the regulatory field; and
— to ensure that all users have well qualified and trained staff, capable of bearing the responsibilities imposed on them.

SPECIAL ARRANGEMENT

E-211.1. In general the Regulations aim to provide a uniform adequate level of safety which is commensurate with the inherent hazard presented by the radioactive material being transported. To the extent feasible, necessary safety features are required to be built into the design of the package, thereby maximizing the contribution to safety of the consignor, who is knowledgeable about the materials being shipped and the package being utilized. By placing primary reliance on the package design and preparation, the need for any special actions during carriage, i.e. by the carrier, is minimized. The overall level of safety which is achieved can be considered
for quickly decontaminating these conveyances or overpacks or freight containers, if applicable, is provided for as long as the conveyances or overpacks or freight containers remain in that dedicated use. Decontamination of these surfaces after every use could lead to unnecessary exposure of workers. On the other hand the external surfaces, which are continually being exposed to the environment, and which are generally much easier to decontaminate, should be decontaminated below the applicable limits after each use.

REQUIREMENTS AND CONTROLS FOR TRANSPORT OF EXCEPTED PACKAGES

E-415.1. In the 1973 Revised Edition (As Amended) of the Regulations, packagings containing very small quantities of radioactive material were denoted as ‘items exempt from the prescriptions’, and the quantities allowed in such packagings were denoted as ‘exemption limits’. However, these packages, which commonly became known as ‘exempt packages’, were not truly exempt from all the prescriptions of the Regulations — the general design requirements for all packages and other controls during transport and storage were applicable.

E-415.2. During the revision process which led to the 1985 Edition of the Regulations, it was agreed to change the nomenclature to indicate that these packages are ‘excepted from further prescriptions (or requirements)’ but are not exempt from all requirements, and to clearly give the name ‘excepted packages’ to this class of packages.

E-415.3. Excepted packages are packages in which the allowed radioactive content is restricted to such low levels that the potential hazards are insignificant and therefore no testing is required with regard to containment or shielding integrity.

E-415.4. For movement by post, the allowed levels of radioactivity are only one-tenth of the levels allowed for excepted packages by other modes of transport for the following reasons:

(a) The possibility exists of contaminating a large number of letters, etc. which would subsequently be widely distributed, thus increasing the number of persons exposed to the contamination;
(b) This further reduction would result in a concurrent reduction in the maximum radiation level of a source which has lost its shielding, and this is considered to be suitably conservative in the postal environment in comparison with other modes of transport; and
(c) A single mailbag might contain a large number of such packages.

E-416.1. The requirement that the radiation level at the surface of an excepted package must not exceed 5 μSv/h (0.5 mrem/h) was established in order to ensure that any radiation dose to members of the public will be insignificant and that sensitive photographic material will not be damaged.
of the uranium or thorium is enclosed in an inactive sheath made of metal or some other substantial material. This provision allows aircraft counterweights made of depleted uranium coated with an epoxy resin, the uranium shielding encased in metal in shipping containers, and X-ray and empty gamma ray radiography and medical treatment devices incorporating depleted uranium shielding to be transported as an excepted package. The inactive sheath, which must cover all readily accessible external surfaces of the uranium or thorium, is required in order to absorb alpha radiation and to reduce the beta radiation level at the surface of the material. The inactive sheath may also control the oxidation of the uranium or thorium and the consequent buildup of loose contamination on the surface of such items.

**Additional requirements and controls for transport of empty packagings**

E-421. Empty packagings which once contained radioactive material may be transported as excepted packages since they present little hazard provided they are conscientiously cleaned to remove loose contamination, are in good condition, and are securely resealed.

**REQUIREMENTS AND CONTROLS FOR TRANSPORT OF LSA MATERIAL AND SCO IN INDUSTRIAL PACKAGES OR UNPACKAGED**

E-422. The concentrations included in the definitions of LSA material and SCO are such that, if packaging were lost, currently allowed materials can produce radiation levels in excess of those deemed acceptable for Type A packages under accident circumstances. Since industrial packages used for transporting LSA material and SCO are not required to withstand transport accidents, a provision was initiated in the 1985 Edition of the Regulations to limit package contents to the amount which would create an external radiation level at 3 m from the unshielded material or object of 10 mSv/h (1 rem/h). This limits accident consequences associated with LSA material and SCO to essentially the same level as that associated with Type A packages, where the $A_1$ value is based on the unshielded contents of a Type A package creating radiation levels of 100 mSv/h (10 rem/h) at a distance of 1 m.

E-426. The higher the potential hazards of LSA material and SCO, the greater the integrity of the package has to be. In assessing the potential hazards, the physical form of the LSA material has been taken into account.

E-427. Conveyance activity limits for LSA material and SCO have been specified, taking the potential hazards into account. Special attention has been given to the greater hazards presented by combustible solids, liquids and gases in the event of accidents.
Additional requirements for industrial package Type 2 (IP-2)

E-519.1. Release of contents considerations for IP-2 packages impose a containment function by the packaging for normal conditions of transport. Some simplification compared to Type A packages was possible owing to the rather immobile character of some LSA material and SCO contents. The alternative use of United Nations packagings is allowed because the United Nations Recommendations require comparable general design requirements and performance tests which have been judged to provide the same level of safety. Whereas leaktightness is also one of the performance test criteria in the United Nations Recommendations, this is not the case with respect to the shielding requirements in the Regulations, which need special attention when United Nations packagings are used.

E-519.2. See paras E-518.1 and E-518.2.

Additional requirements for industrial package Type 3 (IP-3)

E-520.1. Release of contents considerations for IP-3 impose the same containment function as for Type A packages for solids, taking into account the higher values of specific activity to be transported in IP-3 packages and the absence of operational controls in non-exclusive use transport. In addition, sufficient ullage shall be foreseen in the case of liquid LSA material in order to avoid hydraulic failure of the containment system. These requirements are consistent with the graded approach of the Regulations.

E-520.2. See paras E-518.1 and E-518.2.

Alternative requirements for tanks and freight containers to qualify as IP-2 and IP-3

E-521. Tank containers designed for the transport of dangerous goods according to international and national regulations have proved to be safe in handling and transport, in some cases even under severe accident conditions. It is generally viewed that a tank container designed in accordance with the United Nations Recommendations and for a test pressure of 265 kPa (which is foreseen in case of dangerous goods of medium danger) is at least as safe as IP-2 and IP-3 in conventional package sizes (boxes, drums, etc.). Nevertheless, the Regulations require that attention shall be given to the shielding requirement, because the United Nations Recommendations for a tank container do not include any shielding requirement.

E-523. If a freight container is designated as an IP-2 or IP-3 packaging, and satisfies the requirements for these packages, it may be used to transport LSA material and SCO. Freight containers designed in accordance with ISO 1496/1 [15] or the CSC Convention [16] have been proved, by the use of millions of units, to provide safe
E-535. To prevent contamination caused by inadvertent leakage of contents through valves, a provision for some secondary device or enclosure for these valves is required by the Regulations. Depending upon the specific design, such a device or enclosure may help to prevent the unauthorized operation of the valve, or in such an event prevent the contents from escaping.

E-536. The requirement of this paragraph is primarily intended to ensure that the radiation shield is constantly maintained around the radioactive substance to minimize any increase in radiation levels on the surface of the package. When the radiation shield is a separate unit the positive fastening device ensures that the containment system is not released except by deliberate intent.

E-537. The design of, and contents limits imposed upon, Type A packages intrinsically limit any possible radiological hazard. This paragraph provides the restrictions on release and degradation of shielding during normal conditions of transport for ensuring safety.

E-538. Ullage is the space available within the package to accommodate the expansion of the liquid contents of the package due to changes in environmental and transport conditions. Adequate ullage ensures that the containment system is not subjected to excessive pressure due to the expansion of liquids, which are generally regarded as incompressible.

E-539.1. The purpose of these two additional tests as specified in para. 625 is to demonstrate an increased capability for a Type A packaging for liquids to withstand impacts and hence to indicate that the fraction of the contents that would be released in an accident would be comparable to that released from a Type A package designed to carry dispersible solids, i.e. the improved retention counteracts the greater ability of liquids to escape from a damaged package.

E-539.2. The package must also be provided with sufficient absorbent material to absorb twice the volume of the liquid contents or be provided with a two-part containment system of the type prescribed. The purpose of this requirement is to provide a supplementary safety barrier, thereby reducing the probability of the liquid escaping from the package even if it escapes from the containment system.

E-539.3. Concerning the reference to Type B packages in para. 539, this requirement covers the case where a user of a Type B package wishes to use that package for shipping less than an A2 quantity of liquid and to designate this package in his shipping papers as a Type A package shipment. By so doing, some administrative burdens are lifted from the consignor and carrier, and since the package has a greater integrity than a standard Type A package, safety is not degraded. In this case, it is not required to meet the provision of adding absorbent material or a secondary outer containment component.
which are softened by water or materials bonded by water soluble glue. Packaging whose outer layers entirely consist of metal, wood, ceramic or plastic or any combination of these materials may be shown to pass the test by reasoned argument.

E-622.1. The free drop test simulates the type of shock that a package would experience if it were to fall off the platform of a vehicle or if it were dropped during handling. In most cases packages would continue the journey after such shocks. Since heavier packages are less likely to be exposed to large drop heights during normal handling, the free drop distance for this test is graded according to package mass. Should a large package experience a significant drop, this drop might be considered an accident and the package would probably not continue its journey without close examination.

E-622.2. For packages designed to contain fissile material only, the free drop from 1.2 m is preceded by a free drop from 0.3 m onto each corner or, for a cylindrical specimen, onto each of the quarters of each rim. The purpose of this test requirement is to check whether any spacers, on which nuclear criticality safety depends, can withstand the normal conditions of transport without unacceptable distortion.

E-622.3. In view of the potential vulnerability to general rough handling of lighter packagings where outer parts may be constructed of fibreboard or wood, the free drop test also requires that, for fibreboard and wood rectangular specimens not exceeding 50 kg in mass, and for fibreboard cylindrical specimens not exceeding 100 kg in mass, a separate sample be subjected to tests simulating rough handling comprising a free drop from a height of 0.3 m onto each of the corners or, in the case of cylindrical packages, onto each of the quarters of each rim.

E-623. The stacking test is designed to simulate the effect of loads pressing on a package over a prolonged period of time and is intended to ensure that the effectiveness of the shielding and containment systems, and any spacers for nuclear criticality safety, will not be impaired. This test duration corresponds to the requirements of the United Nations Recommendations [1].

E-624. The penetration test is intended to ensure that the contents will not escape from the containment system if a slender object such as a length of metal tubing or a handlebar of a falling bicycle should strike and penetrate the outer layers of the packaging.

Additional tests for Type A packages designed for liquids and gases

E-625. These additional tests for a Type A package designed to contain liquids or gases are imposed because liquid or gas radioactive material has a greater possibility of leaking out and dispersing from a package than solid material. The more severe test requirements are imposed in order to reduce the probability of this occurring.
Type A packages. Type A packages are intended to provide economical transport for large numbers of small activity consignments, while at the same time achieving a high level of safety. The contents limits are set so as to ensure that the radiological consequences of severe damage to a Type A package are not unacceptable and design approval by the competent authority is not required, except for packages containing fissile material.

Activities in excess of the Type A package limits are covered in the Regulations by the requirements for Type B packages, which do require competent authority approval. The design requirements for Type B packages are such as to reduce to a very low level the probability of significant activity release from such packages as a result of a very severe accident.

Originally, radionuclides were classified into seven groups for transport purposes [49, 50], each group having its Type A package contents limits for special form radioactive material and for material in all other forms. Special form radioactive material was defined as that which was non-dispersible when subject to specified tests. In the 1973 Regulations the group classification system was developed into the $A_1/A_2$ system [40, 41], in which each nuclide has a Type A package contents limit, $A_1$ curies, when transported in special form and a limit, $A_2$ curies, when not in special form.

The dosimetric bases of the $A_1/A_2$ system relied upon a number of somewhat pragmatic assumptions. A whole body dose limit of 3 rem (30 mSv) was assumed in the derivation of $A_1$ although in calculating $A_1$ values the exposure was limited to 3 R at a distance of 3 m in a period of 3 hours (see para. 4.12 of Ref. [73]). Also, an intake of $10^{-6} \times A_2$, leading to half the maximum permissible annual intake for a radiation worker, was assumed in the derivation of $A_2$ as a result of a 'median' accident. The median accident was defined arbitrarily as one which leads to complete loss of shielding and to a release of $10^{-3}$ of the package contents in such a manner that $10^{-3}$ of this released material was subsequently taken in by a bystander. The $Q$ system described here includes consideration of a broader range of specific exposure pathways than the earlier $A_1/A_2$ system. Many of the assumptions made are similar to those stated, or implied, in the 1973 Edition of the Regulations, but in situations involving the intake of radioactive material use is made of new data and concepts recently recommended by the ICRP [2, 48]. In particular, subjective assumptions are made regarding the extent of package damage and release of contents, as discussed later, without reference to a 'median' accident.

AI.3. BASIS OF THE $Q$ SYSTEM

Under the $Q$ system a series of exposure routes are considered, each of which might lead to radiation exposure, either external or internal, to persons in the vicinity of a Type A package involved in a severe transport accident. The dosimetric routes are illustrated schematically in Fig. 1 and lead to five contents limit values $Q_A$, $Q_B$, $Q_C$, $Q_D$, and $Q_E$. 

This publication is no longer valid
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Combined with the dose rate limit of 10 rem·h⁻¹ at this distance cited earlier, this leads to a $Q_A$ value for californium-252 of 0.095 TBq, which is more restrictive than the $Q_F$ value of 10 TBq obtained on the basis of the revised expression for special form alpha emitters. The neutron component dominates the external dose due to a californium-252 source and similar considerations apply to the two other potential spontaneous fission sources curium-248 and californium-254. The $Q_A$ values for these radionuclides were evaluated assuming the same dose rate conversion factor per unit activity as for the californium-252 source quoted above, with allowance for their respective neutron emission rates relative to that of this source.

**AI.5.2. Bremsstrahlung radiation**

The $A_1/A_2$ values tabulated in the 1973 Edition of the Regulations are subject to an upper cut-off limit of 1000 Ci in order to protect against possible effects of bremsstrahlung radiation [40]. Within the $Q$ system this cut-off is retained at 40 TBq. However, it is now recognized as an arbitrary cut-off and is not specifically associated with bremsstrahlung radiation or any other dosimetric consideration.

**AI.5.3. Parent nuclides of short lived daughters**

The special case of short lived daughters which may come into equilibrium with a longer lived parent during transit is treated under the $Q$ system as in the 1973 Edition of the Regulations [40]. Thus, on the basis of an assumed maximum journey time of 50 days, short lived daughters of half-life less than 10 days are assumed to be in equilibrium with a longer lived parent. In such cases $Q$ values, and hence $A_1/A_2$ values, for both the parent and daughter nuclides are calculated and the most limiting values are assigned to the parent. Furthermore, where this procedure had been applied this has been indicated in the tabulations of $A_1$ and $A_2$ values. Finally, in cases where daughter nuclides have half-lives either greater than 10 days or greater than that of the parent, the parent and such daughters should be treated as mixtures of different radionuclides and their Type A package contents limits determined as discussed below. The tabulation of $A_1/A_2$ values considered below has been expanded beyond that given in the 1973 Edition of the Regulations to include all radioisotopes of half-life greater than or equal to 10 days.

**AI.5.4. Tritium and its compounds**

During the development of the $Q$ system it was felt that liquids containing tritium should be considered separately. The model used was a spill of a large quantity of tritiated water in a confined area followed by a fire. Resulting from these assumptions the $A_2$ value for tritiated liquids was set in the 1985 Edition of the Regulations at 40 TBq with an additional condition that the concentration should be smaller than 1 TBq/L.
Comments received during the review process made it clear that the model used does not represent the common situation where very small quantities of highly concentrated tritiated liquids are shipped. It does, however, represent an accident involving LSA-II, for which a concentration limit of 1 TBq/L already exists. For many consignments the limits set would require the use of Type B packages without a real justification.

On the basis of the recommendations of a consultants group it was decided to change the special limits of tritiated liquids and make the $A_2$ value of 40 TBq completely general without any restriction on concentration.

Page 82 should be deleted
The 1973 Edition of the Regulations recognized a category of materials whose specific activities are so low that it is inconceivable that an intake could occur which would give rise to a significant radiation hazard, namely low specific activity (LSA) materials. These were defined in terms of a model where it was assumed that it is most unlikely that a person would remain in a dusty atmosphere long enough to inhale more than 10 mg of material [73]. Under these conditions, if the specific activity of the material is such that the mass intake is equivalent to the activity intake assumed to occur for a person involved in an accident with a Type A package, namely $10^{-6} A_2$, then this material should not present a greater hazard during transport than the quantities of radioactivity transported in Type A packages. This hypothetical model is retained within the Q system and leads to an LSA limit of $10^{-4} \times Q_c \text{ g}^{-1}$; thus the Q values for those radionuclides whose specific activity is below this level are listed as 'Unlimited'. In the cases where this criterion is satisfied the radioactivity associated with 10 mg of the nuclide is less than the appropriate ALI value recommended by the ICRP.

Natural uranium and thorium, depleted uranium and other materials such as uranium-238, thorium-232, uranium-235, etc. satisfy the above LSA criterion, as does uranium enriched to $\leq 5\%$ in uranium-235. However, for uranium-235 enrichments in the range from 5 to 20% the permitted intakes of material estimated on the basis of the model outlined above range from 10 to 2.7 mg because of the presence of the uranium-234 and uranium-236. These levels of intake compare with a maximum permitted daily intake of 2.5 mg of uranium recommended by the ICRP on the basis of chemical toxicity considerations [70]. Such considerations will be more restrictive than the radiological limits embodied within the Q system for
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*a* $Q_f$ tabulated in place of $Q_A$.

*b* $Q_e$ tabulated in place of $Q_D$.

*c* $A_1$ and/or $A_2$ value limited by daughter product decay.

*d* $Q_A$ limited by spontaneous fission.

*e* $T$ values for liquids only.

*f* $A_1$ and $A_2$ are unlimited for radiation control purposes only. For nuclear criticality safety this material is subject to the control placed on fissile material.
Appendix II

DERIVATION OF ALLOWABLE RELEASE RATES FOR TYPE B PACKAGES

AII.1. RELEASE RATES FOR NORMAL TRANSPORT

In the determination of the maximum allowable release rate for Type B packages under the conditions of normal transport in the 1973 Edition of the Regulations the most adverse expected condition was judged to be represented by a worker spending 20% of his working time in an enclosed vehicle of 50 m$^3$ volume, with 10 air changes per hour. The vehicle was considered to contain a Type B package leaking activity at a rate of r per hour and it was assumed conservatively that the resulting airborne activity concentration was in equilibrium at all times. On this basis the annual intake of activity via inhalation $I_a$ for a person working 2000 hours per year with an average breathing rate of 1.25 m$^3$·h$^{-1}$ was evaluated as:

$$I_a = \frac{r}{50 \times 10} \times 1.25 \times 2000 \times 0.2 = r$$

Thus the maximum intake over one year is equal to the quantity of activity released in one hour. This intake was equated with the maximum permissible quarterly dose for occupational exposure (3 rem to whole body, gonads, red bone marrow; 15 rem to skin, thyroid, bone; 8 rem to other single organs), which from the determination of $A_2$ corresponded to an intake of $A_2 \times 10^{-6}$ [73]. Hence $r \leq A_2 \times 10^{-6}$ per hour.

This derivation assumes that all of the released material becomes airborne and is available for inhalation, which may be a gross overestimate for many materials. Also equilibrium conditions are assumed to pertain at all times. These factors, together with the principle that leakage from Type B packages should be minimized, indicate that the exposure of transport workers will be only a small fraction of the ICRP limits for radiation workers [2]. In addition, this level of conservatism is considered adequate to cover the unlikely situation of several leaking packages contained in the same vehicle.

In the 1985 Edition of the Regulations the maximum allowable release rates for Type B packages under normal transport conditions are unchanged, although some of the parameters used in the above derivation have been updated. In particular, in the most recent recommendations of the ICRP the earlier quarterly limits employed above have been replaced by annual dose or intake limits for radiation workers [19]. These in turn have been incorporated into the improved method,

Modifications are marked with a vertical line in the right margin of the text for easy location.
# CONTENTS

## SECTION I. INTRODUCTION
- Purpose and scope .............................................. 1
- Definitions for the purpose of the Regulations ............ 2

## SECTION II. GENERAL PROVISIONS
- Radiation protection ........................................... 12
- Emergency response ........................................... 14
- Quality assurance ............................................... 14
- Compliance assurance .......................................... 15
- Special arrangement ........................................... 20

## SECTION III. ACTIVITY AND FISSILE MATERIAL LIMITS
- Basic $A_1/A_2$ values ........................................... 21
- Determination of $A_1$ and $A_2$ .................................. 21
- Contents limits for packages .................................... 22

## SECTION IV. PREPARATION, REQUIREMENTS AND CONTROLS FOR SHIPMENT AND FOR STORAGE IN TRANSIT
- Package inspection requirements ............................ 23
- Transport of other goods ....................................... 24
- Other dangerous properties of contents ...................... 25
- Requirements and controls for contamination and for leaking packages .............................. 27
- Requirements and controls for transport of excepted packages ........................................... 29
- Requirements and controls for transport of LSA material and SCO in industrial packages or unpackaged ............................................... 31
- Determination of transport index (TI) ....................... 31
- Limits on transport index and radiation level for packages and overpacks .............................. 32
- Categories ..................................................... 34
- Marking, labelling and placarding ............................. 34
- Consignor's responsibilities .................................... 37
- Transport ...................................................... 38
- Storage in transit ............................................... 45
- Customs operations ............................................ 46
- Undeliverable packages ........................................ 48
documents of international organizations need to be applied. Generally, the other
dangerous properties are controlled as subsidiary hazards. However, according to
the instructions of the International Civil Aviation Organization, for example, the
other dangerous properties take precedence for excepted packages. Appendix I
contains a list of the major documents of the international and regional organizations.

A-105.2. See also paras A-208 and A-407.1 to A-407.9.

A-106.1. Although the intent of the Regulations is to provide for the requisite safety
in transport without the need for specified routing, the regulatory authorities in some
Member States have imposed routing requirements. Routing restrictions are usually
imposed on shipments of spent fuel and other high activity materials. In prescribing
routes, normal and accident risks, both radiological and non-radiological, as well as
demographic considerations should be taken into account. Policies embodied in the
routing restrictions should be based upon all factors which contribute to the overall
risk in transporting large amounts of radioactivity and not only on concerns for
'worst case' scenarios, i.e. 'low probability/high consequence' accidents.

A-106.2. Through a Co-ordinated Research Programme of the IAEA a computer
based environmental impact code INTERTRAN [2] has been developed and is avail­
able for use by Member States. In spite of many uncertainties, including the use of
generalized models and the difficulty of selecting adequate input values for accident
conditions, this code is useful for calculating and understanding, at least on a qualita­
tive basis, the factors which are significant in determining the radiological impact
from the transport of radioactive materials. These factors are the important aspects
which should be considered in any routing decision.

A-106.3. In some Member States the authorities at the state, provincial or even local
government levels may be involved in routing decisions. In these cases it is often
necessary either to provide them with evaluations to assess alternative routes or to
provide them with very simple methodologies which they can use. For routing
decisions involving a single mode of transport, many simplifying assumptions can
be made and common factors can be assigned which result in easy to use relative
risk evaluation techniques. For example, the Government of the United States of
America applies such an approach [3] and it has been found that both local and state
governments can play a role in the route selection process.

A-109. Users of the Regulations should be aware that, in accordance with this
provision, a Member State may require in its national regulations that an additional
approval be given by its competent authority for a Type B(U) package whose design
has already been approved in another country and which is to be used for domestic
transport on its territory.
DEFINITIONS FOR THE PURPOSE OF THE REGULATIONS

A-116.1. The competent authority is the one organization defined by legislative or executive authority to act on behalf of a nation, or an international authority, in
matters involving the transport of radioactive materials. The legal framework of a country determines how a national competent authority is designated and is given the responsibility to ensure application of the Regulations. In some instances, authority over different aspects of the Regulations is assigned to different agencies, depending on the transport mode (air, road, rail or water), or the package and radioactive material contents (Type A, Type B, special form, fissile) or on the hazard associated with the material (radioactive or other dangerous properties). A national competent authority may in some cases delegate the approval of package designs and certain types of shipments to another organization having the necessary technical competence. National competent authorities also constitute the competent authorities referred to in any conventions or agreements on the transport of radioactive material to which the country adheres.

A-116.2. The competent authority should make the consignors, carriers, consignees and public aware of its identity and how it may be contacted. It is helpful to publish the organizational identity (department, administration, office, etc.), with a description of the duties and activities of the organization in question as well as detailed mailing address, telex numbers, and telephone numbers.

A-116.3. The primary source of competent authority identifications is the List of National Competent Authorities for transport, which is updated and published annually by the IAEA. Each country should ensure that the listed information is current and accurate. The IAEA requests verification of this information annually and prompt responses by Member States will ensure the continued value of this list.

A-116.4. Some competent authorities have formed an informal group, known as the 'Radioactive Transport Study Group', which meets periodically to discuss problems of mutual interest in the national and international administration of the IAEA Regulations. The membership in 1986 included representatives of Australia, Belgium, Canada, the Federal Republic of Germany, France, Italy, Japan, the Netherlands, Poland, Sweden, the United Kingdom and the United States of America. It should be emphasized that the group has no executive powers, but discusses problems freely with an interest in obtaining consensus solutions which will help assure compliance and, at the same time, simplify the implementation of the transport Regulations.

Compliance assurance


Contamination

A-122. Any surface with levels of contamination lower than 0.4 Bq/cm² 
(10⁻⁵ µCi/cm²) for beta and gamma emitters and low toxicity alpha emitters, or
0.04 Bq/cm² ($10^{-6}$ µCi/cm²) for all other alpha emitters is considered as a non-contaminated surface in applying the Regulations. For instance, a non-radioactive solid object with levels of surface contamination lower than the above limits is out of the scope of the Regulations and no requirement is applicable for its transport.
SECTION II
GENERAL PROVISIONS

RADIATION PROTECTION

A-201.1. The basic principles for radiation protection cover all activities involving ionizing radiation. The requirements for the transport of radioactive materials comply with the Basic Safety Standards for Radiation Protection, IAEA Safety Series No. 9 [6].

A-201.2. The term ‘transport workers’ usually covers all workers involved in all aspects of transport. The situation may vary from country to country and transport mode to transport mode.

A-201.3. In radiation protection, the system of dose limitation specified in Section IV of Safety Series No. 9 is summarized as follows:

— Justification of practice
  No practice shall be adopted unless its introduction produces a positive net benefit;

— Optimization of radiation protection
  All exposures shall be kept as low as reasonably achievable, economic and social factors being taken into account; and

— Dose limits
  The dose to individuals shall not exceed the limits for the appropriate circumstances.

A-202.1. In the past, practical radiation protection was concerned mainly with ensuring compliance with ‘dose limits’ with less regard being paid to the other principles. In the currently recommended system of dose limitation more emphasis is placed on justification of practice and optimization of radiation protection. The dose limits are introduced as limiting conditions constraining the justification and optimization procedures, rather than permissible values to be used without optimization for the purposes of planning and design. For example, risks other than radiological may dominate the optimization procedure.

A-202.2. The IAEA, with the assistance of Member States and international organizations, has developed guidance on optimization of radiation protection in the transport of radioactive material [7]. Therefore, further guidance will not be provided here.

A-202.3. Workers involved with radioactive materials require training, especially at the beginning of the work. The extent of the radiation protection training depends
on the nature of transport operations. Reference [8] is an example of such guidance in handbook form.

A-203.1. Assessments of radiation exposure of workers and members of the public (including measurements where indicated) will, in addition to satisfying this requirement, provide necessary input to the competent authority and will help to achieve and maintain public confidence.

A-203.2. In order to comply with para. 203, information on the radiation doses to workers and to members of the public should be collected and reviewed at intervals of about 5 years. More frequent reviews should be made if circumstances warrant, e.g. if significant changes in transport patterns occur and when a new radioactive material related technology is introduced. The collection of relevant information may be achieved through a combination of radiation measurements and assessments.

A-204. Three categories for monitoring and assessing radiation doses are shown in para. 204. Most transport workers will be in the first category, where individual doses are most unlikely to exceed 5 mSv (500 mrem) per year. If higher doses are expected, then environmental monitoring and dose assessment are necessary. In many cases environmental monitoring may be satisfied by radiation level measurements in occupied areas at the start and end of a particular stage of a journey. In some cases however, air monitoring, surface contamination checks and personal monitoring may also be required.

A-205.1. The Regulations state the principles of radiation protection which are to be applied in the determination through calculations of segregation distances (i.e. minimum distances between radioactive material packages and regularly occupied areas of a conveyance) and of dose rates in regularly occupied areas. For practical purposes it may be helpful to prepare these data in the form of segregation tables.

A-205.2. For developing procedures for properly segregating radioactive material from persons during transport and storage, the limiting dose values are, for workers, 5 mSv (500 mrem) per year and, for the public, 1 mSv (100 mrem) per year to members of the critical group (defined in para. 908 of Ref. [6]). These values are for segregation distance or dose rate calculation purposes only and are required to be used together with hypothetical but realistic parameters in order to obtain appropriate segregation distances and dose rates.

Provision for avoiding radiation damage to film

A-206. The different time durations involved for sea transport (in terms of days or weeks) and air or land transport (in terms of hours or days), mean that different tables of segregation distances are used so that the total film exposure during transit
is the same for each mode. More than one mode of transport and more than one shipment may be involved in the distribution and ultimate use of photographic film. Thus, when segregation distance tables for film are being established for a specific transport mode, only a fraction of the limit prescribed in para. 206 should be committed to that mode.

EMERGENCY RESPONSE

A-207. To assist national authorities in preparing for and responding to transport accidents involving radioactive material, a Technical Document was published in 1982 [9] by the IAEA on Emergency Response Planning. It is intended to publish this material eventually as a Safety Series document.

A-208. In the event that the integrity of a package’s containment system is violated in an accident, air and/or water may reach and, in some cases, chemically react with the contents. For some radioactive materials, these chemical reactions may produce caustic, acidic, toxic or poisonous substances which could be dangerous to people and the environment. Consideration should be given to this problem in the design of the package and in emergency response planning procedures to reduce the consequences of such reactions. In doing so, the quantities of materials involved, the potential reaction kinetics, the ameliorating effects of reaction products (self-extinguishing, self-plugging, insolubility, etc.), and the potential for concentration or dilution within the environment should all be considered. Such considerations may lead to restrictions on the package design, or its use, which go beyond considerations of the radioactive nature of the contents. Guidance on UF₆ transport is planned to be published in the IAEA-TECDOC Series.

QUALITY ASSURANCE

A-209.1 Organizations concerned with the transport of radioactive materials are required to develop and maintain an adequate quality assurance programme to ensure compliance with the Regulations and demonstrate that compliance to the competent authority. All aspects of transport mentioned in paras 103 and 209 should be covered by the programme. Appendix IV contains the foundation for such a programme and specifically covers the objectives and principles. The Appendix gives guidance to allow individual programmes to be developed flexibly to account for the wide variety of package designs and transport activities to be covered as well as the different approaches which may be required by the competent authorities of each Member State.
A-209.2. Each programme should be tailored to the specific organizational structure for which the programme is prepared, taking into account the specific transport activities of that organization.

A-209.3. The extent of the quality assurance programmes will depend on the type of transport activities being considered, ranging from minor requirements for the infrequent consignor of excepted packages, to extensive detailed requirements for regular consignors of packages subject to competent authority approval. Appendix V gives guidance in the form of a matrix on how to address each aspect of the quality assurance.

A-209.4. Each quality assurance programme should be available for review and audit by the respective competent authority or other applicable authority.

A-209.5. The following examples of non-conformity can easily be prevented by implementing an effective quality assurance programme:

— Failure to properly package a radioactive material
— Poor condition of packaging due to lack of maintenance, especially in the case of exposure devices and source changers used for radiography purposes
— Failure to properly prepare, label or document packages
— Understatement of Transport Index of packages — numbers specified on labels lower than true radiation level at an intermediate stage in journey (short-life nuclide) owing to the source being assessed at arrival radiation level or improper measurement performed prior to journey
— Failure to placard a vehicle correctly
— Improper removal of placards and labels from vehicles
— Packages insecurely stowed or improperly handled, resulting in lost and/or damaged packages
— Packages improperly stowed, inhibiting adequate heat rejection
— Improper application of exclusive use shipment controls
— Failure to comply with special arrangement conditions.

COMPLIANCE ASSURANCE

A-210.1. An effective programme for compliance assurance by a competent authority should take account of all of the users of the Regulations, i.e. persons or organizations which at one time or another may be subject to the requirements of the Regulations such as

— consignors (shippers)
— carriers
— intermediaries (forwarders, brokers, warehousemen)
— packaging suppliers/manufacturers
— multiple regulatory organizations (i.e. shared responsibilities).
the developing and sponsoring of seminars, conferences, short courses, etc. for regulatory, carrier and other personnel, to make clear the correct application of the Regulations.

SPECIAL ARRANGEMENT

A-211.1. To satisfy the basic conditions for the approval of transport under special arrangement the applicant is required to demonstrate that the overall level of safety provided in the package design features and the operational controls during transport is at least equivalent to that which would be achieved if all the applicable requirements were met. Subject always to the discretion of the competent authorities concerned with the shipment in question, it is possible to establish this by means of safety arguments ranging from considered judgement based on relevant experience to full probabilistic risk analysis. The applicability of the latter will of course be limited by the availability of appropriate information on the probable level of risk based on the assumption of full compliance with the applicable regulatory provisions themselves.

A-211.2. Approval under special arrangement will be sought in respect of shipments where variations from standard package design features result in the need to apply compensatory safety measures in the form of more stringent operational controls.

A-211.3. Details of possible additional controls which can be used in practice for this purpose are included in para. A-721.
SECTION III
ACTIVITY AND FISSION MATERIAL LIMITS

BASIC $A_1/A_2$ VALUES

A-301.1 In a number of provisions of the Regulations it is necessary to know the $A_1$ or $A_2$ values for a radionuclide or mixtures of radionuclides. For the nuclides listed in Table I the values in TBq should be used. The values listed in Table I in Ci are for information only and are always less, in absolute terms, than the TBq values — in some cases significantly so owing to the methods of rounding used to select the respective values. The curie values are not intended for calculations or documentation used to establish contents limits.

A-301.2 In cases where the $A_1$ or $A_2$ value is listed as ‘Unlimited’, unlimited quantities apply wherever the respective $A_1$ or $A_2$ value is used (e.g. quantity limits for excepted packages, Table IV).

DETERMINATION OF $A_1$ AND $A_2$

A-303. In the event that $A_1$ or $A_2$ values need to be calculated the methods outlined in Appendix I in Safety Series No. 7 should be used. Two situations are considered here. First, a decay chain including one or more radionuclides in equilibrium in which the half-lives of all daughters are less than ten days and in which no daughter has a half-life more than the parent nuclide, and second, any other situation. In the former case only the chain parent need be considered because the contribution of the daughters was considered in developing the $A_1/A_2$ values (see Appendix I of Safety Series No. 7); whereas, in the latter case, all the nuclides should be considered separately and considered as a mixture of radionuclides in accordance with para. 304.

A-304. Reactor plutonium recovered from low enriched uranium spent fuel (less than 5% uranium-235) constitutes a typical example of a mixture of radionuclides with known identity and quantity for each constituent. Calculations according to para. 304 result in activity limits independent of the abundance of the plutonium isotopes and the burnup within the range 10 000 MW·d/t to 40 000 MW·d/t.
A-401.6. In cases where criticality safety is dependent on the presence of neutron absorbers it is preferred that the neutron absorber be a solid and an integral part of the packaging. Solutions of absorbers are not endorsed for this purpose because their continued presence cannot be assured.

A-401.7. For further information see Refs [10–13].

Before each shipment

A-402.1. The certificate of approval is the evidence that a package design of an individual package meets the regulatory requirements and that the package may be used for transport. The provisions of para. 402 are designed to ensure that the individual package continues to comply with these requirements. Each check should be documented and initialled by the person directly responsible for that operation. Specific values should be recorded, even when within tolerances, and compared with results of previous tests, so that any indication of deterioration may become apparent. The completed documents should be retained on file in conformance with quality assurance requirements (see para. 209).

A-402.2. Inspection and test procedures should be developed to ensure that the requirements of paras 402(a) and 402(b) are satisfied. Compliance should be documented as part of the quality assurance programme (see para. 209).

A-402.3. To be in compliance with para. 402(c), it is recommended that detailed procedures be developed and followed to ensure that steady state conditions have been reached by measuring the temperature and pressure over a defined period. In the performance of any test it should be ensured that the method selected does not degrade the integrity of the package and that it provides the required sensitivity. Non-conformance with the approved design requirements should be fully documented and also reported to the competent authority which approved the design.

A-402.4. Every Type B package should be tested, after loading and before transport, to ensure compliance with the required leaktightness standard (see para. 402(d)). Some national authorities may permit an assembly verification procedure followed by a less stringent leakage test as offering equivalent confidence in meeting the design conditions. It is recommended that the competent authority of the country concerned be consulted if such a procedure is envisaged.

A-402.5. 'Heels' of residual material tend to build up in UF₆ packagings upon emptying. These 'heels' are generally not pure UF₆ but consist of materials (impurities) which do not sublime as readily as UF₆, such as UO₂F₂, uranium daughters, fission products and transuranic elements. Steps need to be taken upon emptying to ensure the package meets the requirements of para. 421 if it is being shipped as an empty packaging; and upon refilling to ensure that radiation levels
local to the 'heel' are not excessively high, that the transport documents properly account for the 'heel' and that the combined UF₆ contents and 'heel' satisfy the appropriate material requirements. Appropriate assessment and cleaning upon either emptying or refilling may be necessary to satisfy the relevant regulatory requirements. For further information see Refs [12, 13].

TRANSPORT OF OTHER GOODS

A-406. The transport regulatory documents of international transport organizations and the provisions laid down in regulatory documents of individual states
A-407.10. Uranium metal and some uranium compounds may be pyrophoric in contact with air or other gases. Uranium powder or fines are generally spontaneously pyrophoric in air or gas mixtures containing oxygen. Uranium turnings, chips, foil, foam or wire may be ignited and become self-supporting in combustion when subjected to friction or vibration, particularly after chemical cleaning or degreasing. Uranium is capable of self-sustaining combustion in air, oxygen, nitrogen and carbon dioxide. Uranium powder in suspension with air can be explosive to a level up to 120 mg/L. Uranium metal in massive sections, or when all surfaces are plated to prevent the impingement of air on the uranium, may be considered non-pyrophoric.
Whichever method or combination of methods is used, care should be taken to prevent excessive and unnecessary exposure of personnel during the measuring process. Special attention should be paid to high radiation levels which could exist when the containment system of an empty packaging is open.

REQUIREMENTS AND CONTROLS FOR TRANSPORT OF LSA MATERIAL AND SCO IN INDUSTRIAL PACKAGES OR UNPACKAGED

A-422. In the case of solid radioactive waste essentially uniformly distributed in a concrete matrix placed inside a thick wall concrete packaging, the shielding of the concrete wall should not be considered as satisfying the condition of para. 422. However, the radiation level at 3 m from the unshielded concrete matrix may be assessed by direct measurement outside the thick wall of the concrete packaging and then corrected to take into account the shielding effect of the concrete wall.

A-425. According to paras 144(a)(iii) and 425(c), SCO-I is allowed to have non-fixed contamination on inaccessible surfaces in excess of the values specified in para. 144(a)(i). Items such as pipes resulting from the decommissioning of a facility should be prepared for unpackaged transport in a way to ensure that there is no release of radioactive material into the conveyance. This can be done, for example, by using end caps or plugs at both ends of the pipes.

DETERMINATION OF TRANSPORT INDEX (TI)

A-428.1. The TI for radiation protection purposes is determined by scanning all surfaces of a package, including the bottom, at 1 m distance. The highest value measured is the value that determines the TI based on radiation levels. Similarly, the TI for a tank, a freight container and unpackaged LSA-I and SCO-I materials is determined by measuring at 1 m from the surfaces, but a multiplication factor according to the size of the load should be applied in order to define the TI. For overpacks this method is only permitted for the original consignor. Where there are protrusions on the exterior surface, the protrusion should be ignored in determining the 1 m distance except in the case of a finned package in which case the measurement should be made at 1 m distance from the external envelope of the package. For unpackaged LSA-I material the surfaces should be considered to be the walls of the conveyance or freight container.

A-428.2. It is relatively simple to make a direct measurement with a hand held monitoring instrument. In practice, only penetrating radiation is taken into account. In some cases consideration should be given to the possibility of radiation increase as a result of the buildup of daughter nuclides during transport. In such cases a proper correction should be applied so that the TI would represent the highest radiation level envisaged during the transport.
Restricting of access to these areas may be achieved by using an enclosed vehicle that can be locked, or by bolting and locking a cage over the package. In some cases the open top of a vehicle with side walls may be covered with a tarpaulin but this type of enclosure would generally not be considered adequate for preventing access.

A-469.2. During transit there should be no unloading or entering into the enclosed area of a vehicle. If the vehicle is being held in the carrier’s compound for any period it should be parked in an area where access is controlled and where people are not likely to remain in close proximity for an extended period. If it is required to do maintenance work on the vehicle for an extended period, then arrangements should be made with the consignor or the consignee to ensure adequate radiation protection, e.g. by providing extra shielding and radiation monitoring.

A-469.3. It is essential to secure a package or overpack to prevent movement during transport which could cause the radiation level to exceed relevant limits or to increase the dose to the vehicle driver. For road transport a package or overpack should be secured for acceleration, braking, and turning as expected during normal conditions of transport. For rail transport, packages should also be secured to prevent movement during ‘humping’ of the rail car. See paras A-462.1 to A-462.5.

A-470.1. In the application of paras 204 and 470(b) consideration should be given to the probable exposure times of drivers and assistants. If the probable exposure time is greater than 750 hours per year, an annual dose in excess of 15 mSv (1.5 rem) could be received at the limiting dose rate of 0.02 mSv/h (2 mrem/h). The vehicle should be loaded in such a way that the radiation level in occupied positions is minimized. This may be achieved by placing packages with higher radiation levels furthest away from the occupied area and placing heavy packages with low radiation levels nearer to the occupied position.

A-470.2. The radiation levels in the normally occupied positions in a vehicle should be measured with portable instruments designed to measure penetrating radiation (i.e. gamma and neutrons), as described in paras A-433.1 and A-433.2.

Additional requirements relating to transport by vessels

A-471. Transport by sea of any package having a surface radiation level exceeding 2 mSv/h (200 mrem/h) is only allowed under special arrangement conditions, except when transported in or on a vehicle under exclusive use and when subject to the conditions of para. 469. However, if the latter situation occurs, it may be desirable for purposes of radiation protection that a specific area be allocated for that vehicle by the master of the ship or the competent authority concerned. This would be appropriate in particular for the transport of such vehicles aboard roll-on/roll-off ships or ferries. Further guidance will be found in the IMDG Code (see Appendix I).
SECTION VI
TEST PROCEDURES

DEMONSTRATION OF COMPLIANCE

A-601.1. It is generally not advisable to perform the tests required in Section VI of the Regulations using the radioactive material which is being evaluated to qualify as either LSA-III or special form radioactive material, or which would be the contents of special form radioactive material capsules or of packages. When determining whether the radioactive material or the intended radioactive contents are to be used in the tests, a radiological safety assessment should be made, consistent with Ref. [6].

A-601.2. The number of specimens actually subjected to the tests should be related to the number of packagings of that type which are to be produced, the frequency of use and the cost. The results of the tests may necessitate an increase in the number of specimens to meet the requirements of the test procedures in respect of maximum damage.

A-601.3. In addition to full scale tests of a package, reference to previous demonstrations of a sufficiently similar nature, scale model tests, calculations, reasoned arguments, or combinations thereof may be used to demonstrate compliance. The decision concerning the method of demonstrating compliance should be based upon all factors involved, complexity of package design and phenomena requiring investigation, availability of facilities, and ability to accurately measure and/or scale responses. Simulated contents of packaging for full scale tests should be carefully chosen to represent the relevant physical characteristics of the actual contents.

A-601.4. When considering reference to previously satisfactory demonstrations of a similar nature, it is necessary to consider all the similarities and the differences between two packages. The areas of difference may require modification of the results of the demonstration. The ways and extent to which the differences and similarities will qualify the results from the previous demonstration depend upon their effects. In an extreme case, a packaging may be geometrically identical to an approved packaging but because of material changes in the new packaging, the reference to the previous demonstration would not be relevant and could not be used.

A-601.5. When scale models are used certain test parameters cannot be adjusted. For example, both time and gravitational acceleration are real, and therefore it will be necessary to adjust the results by use of scaling factors.
A-601.6. When scale models are used to determine damage, due consideration should be given to the mechanisms which cause the distortion. This is because damage due to elasticity, plasticity and instability may have different scale factors as a result of different parameters in the test being affected. Also, because the demonstration of compliance requires the combination of three tests (penetration, drop and thermal tests), conflicting requirements for the test parameters may require a compromise, which in turn would give results requiring scale factoring. In summary, the effect of scaling for all areas of difference should be considered.
A-601.7. Experience has shown that the testing of scale models may be very useful for demonstrating compliance with certain specific requirements of the Regulations, particularly the mechanical tests. Attempts to perform thermal tests using scale models are not recommended (see para. A-628.14). In mechanical tests, the conditions of similitude are relatively simple to create, provided the same materials and suitable methods of construction are used for the model as for the full sized package. Thus, in an economical manner, it is possible to study the relation of package orientation and the resulting damage, and the overall deformation of the package, and to obtain information concerning the deceleration of package parts. In addition, many design features can be optimized by model testing.

A-601.8. The details which should be included in the model are a matter of judgment and depend on the type of test for which the model is intended. For example, in the determination of the structural response from an end impact, the omission of lateral cooling fins from the scale model may result in more severe damage. This type of consideration may greatly simplify construction of the model without detracting from its validity. Only pertinent structural features which may influence the outcome of the test need be included. It is essential, however, that the materials of construction for the scale model and the full sized package are the same and that suitable construction and manufacturing techniques are used. In this sense, the construction and manufacturing techniques which will replicate the mechanical behaviour and structural response of the full sized package should be used, giving consideration to such processes as machining, welding, heat treatment and bonding methods. The stress-strain characteristics of the construction materials should not be strain rate dependent to a point which would invalidate the model results. This point needs to be made in view of the fact that strain rates in the model may be higher than in the full sized package.

A-601.9. In some cases it may not be practical to scale all components of the package precisely. For example, consider the thickness of an impact limiter compared to the overall length of the package. In the model, the ratio of the thickness to the overall length may differ from that of the actual package. When any appreciable geometrical discrepancy exists between the actual package and the model to be tested, the behaviour of both when subjected to the 9 m drop should be compared by computer code analyses to determine whether the effect of geometrical discrepancy is a significant consideration. The computer code employed should be a code which has been verified through appropriate bench mark tests. If the effects of the discrepancies are not significant, the model would be considered suitable for a scale model drop test. This applies to a scale ratio of 1:4 or greater.

A-601.10. The scale factor chosen for the model is another area where a judgement needs to be made since the choice of scale factor depends on the accuracy necessary to ensure an acceptable model representation. The greater the deviation from full scale, the greater the error that is introduced. Consequently, the reduction of scale
might be greater for a study of package deformation as a whole than for testing certain parts of the package and in some cases the scale factor chosen may be determined by the particular type of test being undertaken. In some tests, such as the penetration tests specified in the Regulations, it will also be necessary to scale the bar in order to produce accurate results. In other cases where the packaging may be protected by a significant thickness of deformable structure, the drop height may need to be scaled.

A-601.11. In general, the scale ratio $M$ (the ratio model dimension:prototype dimension) should be not less than 1:4. For a model with a scale ratio of 1:4 or larger, the effect of strain rate dependence on the material mechanical properties will be negligibly small.

A-601.12. Scaling of drop tests is possible, taking into account the limitations given below, as a result of the following model laws, which are valid when the original drop height is maintained:

\[
\begin{align*}
\text{Accelerations:} & \quad a_{\text{model}} = \frac{1}{M} \cdot a_{\text{original}} \\
\text{Forces:} & \quad F_{\text{model}} = M^2 \cdot F_{\text{original}} \\
\text{Stresses:} & \quad \sigma_{\text{model}} = \sigma_{\text{original}} \\
\text{Strains:} & \quad \varepsilon_{\text{model}} = \varepsilon_{\text{original}}
\end{align*}
\]

A-601.13. For lightweight models, the model attitude or velocity during drop testing could be affected by such things as the swing of an umbilical cord carrying wires for acceleration sensors or strain gauges, or by wind effects. Experience suggests that, for packages with mass up to 1000 kg, full scale models should be used for the test, or special guides should be used.

A-601.14. When acceleration sensors are used to evaluate impact behaviour of the package, the cut-off frequency should be considered. The cut-off frequency should be selected to suit the structure (shape and dimension) of the package. Experience suggests that, for a package with a mass of 100 Mg with impact limiter, the cut-off frequency should be 100 to 200 Hz, and that, for smaller packages with a mass of $m$ [Mg], this cut-off frequency should be multiplied by a factor $(100/m)^{1/3}$.

A-601.15. When an application for approval of a package design is based to any extent on scale model testing, the application should include a demonstration of the validity of the scaling methods used. In particular, such a demonstration should include:

- definition of the scale factor;
- demonstration that the model constructed reproduces sufficiently accurately the details of the package or packaging parts to be tested;
- a list of parts or features not reproduced in the model;
- justification for deletion of parts or features in the model; and
- justification of the similitude criteria used.
A-601.16. Care has to be exercised when planning the instrumentation and analysis of either a scale model test or a full scale test. It is necessary to ensure that adequate and correctly calibrated instrumentation and test devices are provided so that the test results may be documented and evaluated in order to verify the test results. At the same time, it is necessary to ensure that the instrumentation, test devices, and electrical connections do not interfere with the model in a way that would invalidate the test results.

A-601.17. In the evaluation of the results of a scale model test, it is necessary to consider not only the damage sustained by the packaging, but, in some cases, the damage to the package contents. In particular, damage to the package contents should be considered when it involves a change in:

- release rate potential;
- parameters affecting criticality;
- shielding effectiveness;
- thermal behaviour.

A-601.18. It might be difficult to extrapolate the results of scale model testing involving seals and sealing surfaces to the responses expected in a full sized package. Although it is possible to acquire valuable information on the deformation and displacement of sealing surfaces with scale models, extrapolation of seal performance and leakage should be approached with caution (A-617.7 to A-617.10). When scale models are used for testing seals it is necessary to consider the possible effect of such factors as surface roughness, seal behaviour as a function of material thickness and type, and the problems associated with predicting leakage rates on the basis of scale model results.

A-601.19. Brittle fracture in testing is treated in Appendix IX.

A-601.20. Calculation is permitted in the demonstration of compliance (see para. 601(d)) when the procedures and parameters are reliable and conservative. This will require the examination of any engineering data used. Material properties in specifications are usually supplied to give a probability of not being under strength of between 95% to 98%. When tests are used for determining material property data, scatter in the data should be taken into account. It is usual to factor results where the number of tests are limited to give a limit of the mean plus twice the standard deviation on a normal (Gaussian) distribution (approximately 95% probability). It is also necessary to consider scatter due to material and manufacturing tolerances unless all calculations are on the worst combination of possible dimensions.

A-601.21. Many calculations will require the use of commercially available computer codes. Prior to their use, two items should be considered as to their reliability. First, is the code applicable for the intended calculation? For example, for
mechanical assessments, can it accept impact calculations, is it suitable for calculating plastic as well as elastic deformations? Secondly, does the computer code adequately represent the packaging under review for the purpose of compliance? To satisfy these two requirements it will, in many cases, be necessary for the user to run 'bench mark' problems, which uses the code to model and calculate the parameters of a problem in which the results are known. For other uses, checks that the input and output balance in load or energy may be required. When the code used is not widely employed and known, proof of the theoretical correctness should also be given.

A-601.22. In the presentation of reasoned argument, care is required that argument is based on engineering experience. Where theory is used, due account should be made of design details which could modify the result of general theory, e.g. discontinuities, asymmetries, irregular geometry, inhomogeneities and variable material properties. The presentation of reasoned argument is a difficult method because of its subjective nature. It should always be based on scientific fact and be supported by engineering experience.

A-602.1. Any post-test assessment method used to assure compliance should incorporate the following techniques as appropriate to the type of package under examination:

- visual examination;
- assessment of distortion;
- seal gap measurements of all closures;
- non-destructive testing; and
- microscopic examination of damaged material.

A-602.2. In the evaluation of damage to a package after a drop test, all damage from secondary impacts should be considered as well. Secondary impact includes all additional impacts between the package and target, following initial impact. For evaluations which are based on numerical methods, it is also necessary to consider secondary impacts. Accordingly, the attitude of the package which produces maximum damage has to be determined with secondary as well as initial impacts taken into account. However, experience suggests that the effect of secondary impact is usually negligible except for a limited number of slender and rigid packages, including:

- a package with an aspect ratio (length to diameter) larger than 5;
- a rigid, large package when significant rebound is expected to occur following the 9 m drop; and
- a package in which the contents are rigid and slender and particularly vulnerable to lateral impacts.

A-602.3. See also the references given in Appendix IX.
internal pressure and temperature measurements may be necessary and, where stress is considered important, strain gauges should be installed. In all cases, the cables carrying signals through the flames should be protected to avoid extraneous voltages created at high temperatures. As an alternative to continuous measurement, the package might be equipped in such a way that instruments could be connected soon after the fire and early enough to measure the peak pressure and temperature. A measurement of leakage can be achieved by pre-pressurization and re-measurement after the thermal test, where necessary making appropriate adjustments for temperature (see para. A-548.1 to A-548.15).

A-628.8. The duration of the test can be controlled by providing a measured supply of fuel calculated to ensure the required 30 minute duration, by removing the supply of fuel a predetermined time before the end of the test, by discharging the fuel from the pool at the end of the test or by carefully extinguishing the fire without affecting the package surfaces with the extinguishing agent. The duration of the test is the time between the achievement of good flame cover and the time at which such cover is lost.

A-628.9. Measurements should continue after the fire, at least until the internal temperatures and pressures are falling. If rain, or other precipitation, occurs during this period a temporary cover should be erected to protect the package and to prevent inadvertent extinguishing of combustion of the package materials, but care should be taken not to restrict heat loss from the package.

A-628.10. Where a fully representative package is subjected to the thermal test, an examination of the package after the test to determine compliance with appropriate requirements (leakage, shielding, etc.) may be sufficient.

A-628.11. Where the test supplies data for analytical evaluation of the package, measurements made during the test should be corrected for non-standard initial conditions of ambient temperature, insolation, internal heat load, pressure, etc. For packages containing liquids, the effects of partial loading, i.e. less than full contents, on the package heat capacity and heat transfer should be assessed.

A-628.12. A furnace test is often more convenient than an open pool fire test. Other possible test environments include pit fires. Any such test is acceptable provided it meets the requirements of para. 628.

A-628.13. Ensuring that the internal temperature increase is not less than that predicted for an 800°C fire ensures that the heat input is satisfactory, but the test should continue for at least 30 minutes, during which the time-averaged environment temperature should be at least 800°C. A high emissivity radiation source should be created by selecting a furnace either with an internal surface area very much larger than the envelope area of the package or with an inherently high emissivity internal surface (0.90 or higher). Many furnaces are unable to reproduce either the desired
emissivity or the convective heat input of a pool fire, so an extension of the test duration might be necessary to compensate. Alternatively, a higher furnace temperature can be used but the test duration should be a minimum of 30 minutes. The furnace wall temperature should be measured at several places, sufficient to show that the average temperature is at least 800°C. The furnace can be pre-heated for a sufficient time to achieve thermal equilibrium, so avoiding a large temperature drop when the package is inserted. The 30 minute minimum duration should be such that the time-averaged environment temperature is at least 800°C.
<table>
<thead>
<tr>
<th>Symbol of radionuclide</th>
<th>Element and atomic number</th>
<th>Half-life</th>
<th>Specific activity$^a$</th>
</tr>
</thead>
<tbody>
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<td>$T_{1/2}$ (m,h,d,a)</td>
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<td>T$_{1/2}$ (m,h,d,a)</td>
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</table>
tissues are well protected by the procedure of establishing segregation criteria based on whole body limits. Finally, the radiation levels used in the procedure are based on the transport index (TI) of a package or on the summation of the TIs in an array of packages. Thus, for arrays of packages, self shielding within the array is not considered and actual radiation levels will be lower than those upon which the calculations are based.

In order to establish minimum segregation distance requirements which will implement the radiation protection principles of the Regulations it is first necessary to develop a model of transport conditions for a given mode of transport. Numerous variables need to be considered in the development of a model. These considerations have been documented for previous calculations made for air transport [18, 46, 47] and for sea transport [18]. Important parameters in such a model will include:

(a) The maximum annual travel periods (MATP) for crew and for the critical groups of members of the public;
(b) The radioactive traffic factors (RTF), defined as the ratio of the annual number of journeys made in company with Category II-YELLOW and Category III-YELLOW packages of radioactive materials\(^4\) to the annual total of all journeys;
(c) The maximum annual exposure times (MAET), for both crew and public, which are the relevant MATP multiplied by the appropriate RTF, i.e.

\[
MAET (h/a) = MATP (h/a) \times RTF; \quad (VI.1)
\]

(d) The applicable dose equivalent limits (DEL) from para. 205 for crew\(^5\) and members of the public; and,
(e) The reference dose equivalent rates (RDER) for crew and members of the public, which are used as the basis for establishing the minimum segregation distances and are derived by dividing the applicable dose equivalent limit by the applicable maximum annual exposure time, i.e.

\[
RDER (mSv/h) = \frac{DEL (mSv/a)}{MAET (h/a)}. \quad (VI.2)
\]

The following provides an example of how segregation distances may be determined for the situations of passenger carrying and cargo-only aircraft. This example

\(^4\) Category I-WHITE packages are excluded from this because they present no essential radiation exposure hazard.

\(^5\) Members of the crew are defined as transport workers and therefore their dose equivalent limit is defined by para. 205(a).
\[ M_{ax} = 2P_{1x} \cos \phi \cos \alpha + \mu[2P_{1x} \sin \phi + M(g-a_z)] \]

\[ P_{1x} = \frac{M[a_x - \mu(g-a_z)]}{2(\cos \phi \cos \alpha + \mu \sin \phi)} \]

Similarly, for the acceleration \( a_y \) we have

\[ P_{1y} = \frac{M[a_y - \mu(g-a_z)]}{2(\cos \phi \sin \alpha + \mu \sin \phi)} \]

Considering the acceleration \( a_z \)

\[ M(a_z - g) = 4P_{1z} \sin \phi \]

\[ P_{1z} = \frac{M(a_z - g)}{4 \sin \phi} \]

Consider the following example. Assume that

\[ a_x = a_y = 2g \]
\[ a_z = 1g \]

The angles \( \alpha = 45^\circ \) and \( \phi = 45^\circ \) and

\[ P_{1x} = \frac{2 Mg}{2(0.5 + 0.707\mu)} \]
\[ P_{1y} = \frac{2 Mg}{2(0.5 + 0.707\mu)} \]
\[ P_{1z} = 0 \]

Assume that \( \mu = 0.4 \), then the tension in tie-down 1:

\[ P_1 = 1.28 Mg + 1.28 Mg + 0 = 2.56 Mg \]

If friction is ignored, \( \mu = 0 \) and the tension in tie-down 1:

\[ P_1 = 2 Mg + 2 Mg + 0 = 4 Mg \]

The tension is almost a factor of 5 greater than the equivalent chocked case considered in Section AVII.2.1.
The following pages replace the corresponding pages of the
Schedule of Requirements for the Transport of Specified
Types of Radioactive Material Consignments, Safety Series
No. 80.

Modifications are marked with a vertical line in the right
margin of the text for easy location.
### TABLE 1.1. ACTIVITY LIMITS, IN TERMS OF $A_1$ OR $A_2$ VALUES, FOR EXCEPTED PACKAGES CONTAINING RADIOACTIVE MATERIAL\textsuperscript{a, b}

<table>
<thead>
<tr>
<th>Physical state of contents</th>
<th>Package limits (post)</th>
<th>Package limits (other modes)</th>
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<tbody>
<tr>
<td><strong>Solids:</strong></td>
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<tr>
<td>other forms</td>
<td>$10^{-4} A_2$</td>
<td>$10^{-3} A_2$</td>
</tr>
</tbody>
</table>

\textsuperscript{a} For specific values of $A_1$ and $A_2$ see Tables I and II of the Regulations.

\textsuperscript{b} For mixtures of radionuclides the method(s) for defining $A_1$ and $A_2$ are provided in paras 304–306 of the Regulations.

### 3. MAXIMUM RADIATION LEVELS

5 $\mu$Sv/h (0.5 mrem/h) on the surface of a package.
9. PLACARDS ON VEHICLES, FREIGHT CONTAINERS AND TANKS

None required for radioactive nature of contents. Placards may be required for other dangerous properties of contents.

10. TRANSPORT DOCUMENTS

Packages shall be described in the transport documents as "RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, 2910, LIMITED QUANTITY OF MATERIAL".

11. STORAGE AND DISPATCH

(a) By post

(i) Domestic — Applicable national regulations shall be complied with.

(ii) International — Consignors shall be authorized by the national authority and packages shall be dispatched by the quickest route (normally by air).

(b) By other modes

No specific provisions.

12. CARRIAGE OF PACKAGES, FREIGHT CONTAINERS AND TANKS

No specific provisions.

13. OTHER PROVISIONS

See Annex I of these Schedules.
TABLE 2.1. ACTIVITY LIMITS, IN TERMS OF $A_1$ OR $A_2$ VALUES, FOR EXCEPTED PACKAGES CONTAINING INSTRUMENTS AND ARTICLES$^a,b$

<table>
<thead>
<tr>
<th>Physical state of contents</th>
<th>Item limits</th>
<th>Package limits (post)</th>
<th>Package limits (other modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Solids:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>special form</td>
<td>$10^{-2} A_1$</td>
<td>$10^{-1} A_1$</td>
<td>$A_1$</td>
</tr>
<tr>
<td>other forms</td>
<td>$10^{-2} A_2$</td>
<td>$10^{-1} A_2$</td>
<td>$A_2$</td>
</tr>
<tr>
<td><strong>Liquids</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$10^{-3} A_2$</td>
<td>$10^{-2} A_2$</td>
<td>$10^{-1} A_2$</td>
</tr>
<tr>
<td><strong>Gases:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tritium</td>
<td>$2 \times 10^{-2} A_2$</td>
<td>$2 \times 10^{-2} A_2$</td>
<td>$2 \times 10^{-1} A_2$</td>
</tr>
<tr>
<td>special form</td>
<td>$10^{-3} A_1$</td>
<td>$10^{-3} A_1$</td>
<td>$10^{-2} A_1$</td>
</tr>
<tr>
<td>other forms</td>
<td>$10^{-3} A_2$</td>
<td>$10^{-3} A_2$</td>
<td>$10^{-2} A_2$</td>
</tr>
</tbody>
</table>

$^a$ For specific values of $A_1$ and $A_2$ see Tables I and II of the Regulations.

$^b$ For mixtures of radionuclides the method(s) for defining $A_1$ and $A_2$ are provided in paras 304–306 of the Regulations.

(b) Packages containing fissile material, in addition to meeting all other requirements for excepted packages, shall also meet at least one of the requirements specified in para. 560 of the Regulations.

(c) The instruments and articles shall be securely packed.

(d) Other dangerous properties shall be taken into account so as to comply with the relevant transport regulations for dangerous goods.

(e) Transport of unpackaged radioactive material is not allowed.

3. MAXIMUM RADIATION LEVELS

5 $\mu$Sv/h (0.5 mrem/h) on the surface of a package.
9. PLACARDS ON VEHICLES, FREIGHT CONTAINERS AND TANKS

None required for radioactive nature of contents. Placards may be required for other dangerous properties of contents.

10. TRANSPORT DOCUMENTS

Packages shall be described in the transport documents as "RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, 2910, INSTRUMENTS", or as "RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, 2910, ARTICLES", as applicable.

11. STORAGE AND DISPATCH

(a) By post

(i) Domestic — Applicable national regulations shall be complied with.

(ii) International — Consignors shall be authorized by the national authority and packages shall be dispatched by the quickest route (normally by air).

(b) By other modes

No specific provisions.

12. CARRIAGE OF PACKAGES, FREIGHT CONTAINERS, TANKS AND OVERPACKS

No specific provisions.

13. OTHER PROVISIONS

See Annex I of these Schedules.
(ii) 2 mSv/h (200 mrem/h) on the external surface of the package or overpack, except when transported under exclusive use by rail or by road, or under exclusive use and special arrangement by vessel or by air.

(c) The radiation level at any point on the external surface of a package containing LSA-I material, transported under exclusive use, shall not exceed 10 mSv/h (1000 mrem/h).

(d) The surface radiation levels for packages or overpacks containing LSA-I material, transported under exclusive use by rail or road, may only exceed 2 mSv/h (200 mrem/h) provided that:

(i) the vehicle is equipped with an enclosure which prevents unauthorized access during transport;
(ii) the package or overpack is secured to retain its position within the enclosure during routine transport; and
(iii) there are no loading or unloading operations between the beginning and end of the shipment.

(e) The surface radiation levels for packages or overpacks containing LSA-I material, transported by a vessel, may only exceed 2 mSv/h (200 mrem/h) provided that either:

(i) they are transported by the vessel in or on a rail or road vehicle which itself is being transported under exclusive use, or
(ii) they are transported under special arrangement.

(f) The surface radiation levels for packages containing LSA-I material, transported by air, may only exceed 2 mSv/h (200 mrem/h) provided they are transported under special arrangement.

4. CONTAMINATION ON PACKAGES, FREIGHT CONTAINERS, TANKS AND OVERPACKS

(a) Non-fixed contamination on the external surfaces of IP-1 or IP-2 packages and on the internal and external surfaces of freight containers, tanks and overpacks used for transporting IP-1 or IP-2 packages shall be kept as low as practicable and shall not exceed the limits specified in Table 5.2.
(b) **Overpacks or freight containers** dedicated to the transport of **LSA-I material under exclusive use** may be excepted from (a) above solely with regard to their internal surfaces and only for as long as they remain under that **exclusive use**.
TABLE 5.2. NON-FIXED CONTAMINATION LIMITS

<table>
<thead>
<tr>
<th>Table III</th>
<th>Beta emitters, gamma emitters, and low toxicity alpha emitters</th>
<th>Alpha emitters — other than those of low toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consignments which include:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) excepted packages of radioactive material;</td>
<td>0.4 Bq/cm(^2)</td>
<td>0.04 Bq/cm(^2)</td>
</tr>
<tr>
<td>(ii) non-radioactive goods; or</td>
<td>(10(^{-5}) μCi/cm(^2))</td>
<td>(10(^{-6}) μCi/cm(^2))</td>
</tr>
<tr>
<td>(iii) both</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other consignments</td>
<td>4 Bq/cm(^2)</td>
<td>0.4 Bq/cm(^2)</td>
</tr>
<tr>
<td></td>
<td>(10(^{-4}) μCi/cm(^2))</td>
<td>(10(^{-5}) μCi/cm(^2))</td>
</tr>
</tbody>
</table>

5. DECONTAMINATION AND USE OF CONVEYANCES, EQUIPMENT OR PARTS THEREOF

413 (a) Conveyances, equipment or parts thereof which have become contaminated above the limits in Table 5.2, or which show a surface radiation level in excess of 5 μSv/h (0.5 mrem/h) in the course of transport of LSA-I material, shall be decontaminated as soon as possible, and in any case before reuse, to levels not exceeding those specified in Table 5.2, and so that the resulting surface radiation level after decontamination does not exceed 5 μSv/h (0.5 mrem/h).

414 (b) A conveyance dedicated to the transport of LSA-I material under exclusive use may be excepted from (a) above solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use.

145, 404 (c) Tanks used for the transport of radioactive material shall not be used for storage or transport of other goods.

6. MIXED CONTENTS OF PACKAGES

403 Other items may be transported in the packaging with LSA-I material, provided there is no interaction between the other items and the LSA-I material or its packaging which would reduce the safety of the package.
7. MIXED LOADING

(a) Mixing of packages of different kinds of radioactive material, including fissile material, and mixing of packages with different transport indexes (TIs) is permitted.

(b) Consignments shall be segregated from other dangerous goods in compliance with the relevant transport regulations. If the consignment is transported under exclusive use the carriage of other goods is permitted provided the arrangements are controlled only by the consignor and it is not prohibited by other regulations.

(c) Radioactive material shall be segregated from undeveloped photographic film so that the radiation exposure of film due to the transport of radioactive material is limited to 0.1 mSv (10 mrem) per consignment of such film.

8. LABELLING AND MARKING OF PACKAGES, FREIGHT CONTAINERS, TANKS AND OVERPACKS

The following requirements apply to packages, freight containers, tanks and overpacks containing LSA-I non-fissile material.

For packages, which may be tanks or freight containers, containing fissile material, and for freight containers and overpacks carrying packages which themselves contain fissile material, see, in addition, Schedule 12.

Any labels which do not relate to the contents shall be removed or covered.

(a) Packages

(i) Completed WHITE or YELLOW labels (see Figs 2, 3 or 4 of the Regulations, as appropriate), with the contents described as “LSA-I”, shall be affixed externally to two opposite sides of packages, or to all four sides of freight containers and tanks when being used as packages.

(ii) Each label shall be marked with the maximum activity of the radioactive contents during transport.

(iii) Each YELLOW label shall be marked with the TI for that package.
131 LSA-II is the second of three groups of radioactive material which, by its nature, has a limited specific activity or for which limits of estimated average specific activity apply. If fissile material is present the requirements of Schedule 12 shall be met in addition to the requirements summarized in this Schedule.

1. MATERIALS

131(b) Low specific activity material (LSA-II) — Radioactive material meeting one of the following requirements:

(a) Water with tritium concentration up to 0.8 TBq/L (20 Ci/L);  
(b) Solids and gases with activity distributed throughout of not more than \(10^{-4}\) A\(_2\)/g; or  
(c) Liquids with activity distributed throughout of not more than \(10^{-5}\) A\(_2\)/g.

2. PACKAGING/PACKAGE

134(b), 426 (a) LSA-II material shall be transported in packagings, which may be tanks or freight containers.

426, 519, 520 (b) The packaging shall meet the design requirements for industrial packages IP-2 (para. 519 of the Regulations) or IP-3 (para. 520 of the Regulations), as appropriate for the form of the LSA-II material as specified in Table 6.1. Alternative requirements for tanks and freight containers to be qualified as IP-2 or IP-3 are given in paras 521-523 of the Regulations.

* Information given in the left margin refers to paragraph numbers, tables and/or figures in the 1985 Edition of Safety Series No. 6, including the 1986 Supplement to Safety Series No. 6.
(d) The surface radiation levels for packages or overpacks containing LSA-II material, transported under exclusive use by rail or road, may only exceed 2 mSv/h (200 mrem/h) provided that:

(i) the vehicle is equipped with an enclosure which prevents unauthorized access during transport;
(ii) the package or overpack is secured to retain its position within the enclosure during routine transport; and
(iii) there are no loading or unloading operations between the beginning and end of the shipment.

(e) The surface radiation levels for packages or overpacks containing LSA-II material, transported by a vessel, may only exceed 2 mSv/h (200 mrem/h) provided that either:

(i) they are transported by the vessel in or on a rail or road vehicle which itself is being transported under exclusive use, or
(ii) they are transported under special arrangement.

(f) The surface radiation levels for packages containing LSA-II material, transported by air, may only exceed 2 mSv/h (200 mrem/h) provided they are transported under special arrangement.

4. CONTAMINATION ON PACKAGES, FREIGHT CONTAINERS, TANKS AND OVERPACKS

(a) Non-fixed contamination on the external surfaces of IP-2 or IP-3 packages and on the internal and external surfaces of freight containers, tanks and overpacks used for transporting IP-2 or IP-3 packages shall be kept as low as practicable and shall not exceed the limits specified in Table 6.2.

(b) Overpacks or freight containers dedicated to the transport of LSA-II material under exclusive use may be excepted from (a) above solely with regard to their internal surfaces and only for as long as they remain under that exclusive use.
<table>
<thead>
<tr>
<th>Table III</th>
<th>Beta emitters, gamma emitters, and low toxicity alpha emitters</th>
<th>Alpha emitters — other than those of low toxicity</th>
</tr>
</thead>
</table>
| Consignments which include: | 0.4 Bq/cm²  
(i) excepted packages of radioactive material; | 0.04 Bq/cm²  
(10⁻⁵ μCi/cm²) |
| (ii) non-radioactive goods; or (iii) both | (10⁻⁶ μCi/cm²) |
| Other consignments | 4 Bq/cm²  
(10⁻⁴ μCi/cm²) | 0.4 Bq/cm²  
(10⁻³ μCi/cm²) |
5. **DECONTAMINATION AND USE OF CONVEYANCES, EQUIPMENT OR PARTS THEREOF**

(a) Conveyances, equipment or parts thereof which have become contaminated above the limits in Table 6.2, or which show a surface radiation level in excess of 5 \( \mu \)Sv/h (0.5 mrem/h) in the course of transport of LSA-II material, shall be decontaminated as soon as possible, and in any case before reuse, to levels not exceeding those specified in Table 6.2, and so that the resulting surface radiation level after decontamination does not exceed 5 \( \mu \)Sv/h (0.5 mrem/h).

(b) A conveyance dedicated to the transport of LSA-II material under exclusive use may be excepted from (a) above solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use.

(c) Tanks used for the transport of radioactive material shall not be used for storage or transport of other goods.

6. **MIXED CONTENTS OF PACKAGES**

Other items may be transported in the packaging with LSA-II material, provided there is no interaction between the other items and the LSA-II material or its packaging which would reduce the safety of the package.

7. **MIXED LOADING**

(a) Mixing of packages of different kinds of radioactive material, including fissile material, and mixing of packages with different transport indexes (TIs) is permitted.

(b) Consignments shall be segregated from other dangerous goods in compliance with the relevant transport regulations. If the consignment is transported under exclusive use the carriage of other goods is permitted provided the arrangements are controlled only by the consignor and it is not prohibited by other regulations.
(e) Maximum radiation levels for conveyances, large freight containers and tanks.

465(b) (i) 2 mSv/h (200 mrem/h) on the surface of the conveyance,
465(b) (ii) 0.1 mSv/h (10 mrem/h) at 2 metres from the surface of the conveyance, and
470(b) (iii) 0.02 mSv/h (2 mrem/h) at any normally occupied position in a road vehicle unless persons occupying such positions are provided with personal monitoring devices.

(f) The total activity in a single conveyance shall not exceed the values specified in Table 6.3.

**TABLE 6.3. CONVEYANCE ACTIVITY LIMITS FOR LSA-II MATERIAL**

<table>
<thead>
<tr>
<th>Physical state of contents</th>
<th>Conveyance other than inland waterway craft</th>
<th>Hold or compartment of inland waterway craft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-combustible solids</td>
<td>No limit</td>
<td>100 A₂</td>
</tr>
<tr>
<td>Combustible solids, and all liquids and gases</td>
<td>100 A₂</td>
<td>10 A₂</td>
</tr>
</tbody>
</table>

(g) Air — Additional restrictions

474 (i) Packages with liquid pyrophoric contents prohibited.
473 (ii) Exclusive use transport in passenger aircraft is prohibited.
475 (iii) Packages having a surface radiation level greater than 2 mSv/h (200 mrem/h) shall only be transported under special arrangement.

(h) Post — Not permitted, except in limited quantities as summarized in Schedule 1.

13. OTHER PROVISIONS

See Annex I of these Schedules.
(e) The surface radiation levels for packages or overpacks containing LSA-III material, transported by a vessel, may only exceed 2 mSv/h (200 mrem/h) provided that either:

(i) they are transported by the vessel in or on a rail or road vehicle which itself is being transported under exclusive use, or

(ii) they are transported under special arrangement.

(f) The surface radiation levels for packages containing LSA-III material, transported by air, may only exceed 2 mSv/h (200 mrem/h) provided they are transported under special arrangement.

4. CONTAMINATION ON PACKAGES, FREIGHT CONTAINERS AND OVERPACKS

(a) Non-fixed contamination on the external surfaces of IP-2 or IP-3 packages and on the internal and external surfaces of freight containers and overpacks used for transporting IP-2 or IP-3 packages shall be kept as low as practicable and shall not exceed the limits specified in Table 7.1.

(b) Overpacks or freight containers dedicated to the transport of LSA-III material under exclusive use may be excepted from (a) above solely with regard to their internal surfaces and only for as long as they remain under that exclusive use.

<table>
<thead>
<tr>
<th>TABLE 7.1. NON-FIXED CONTAMINATION LIMITS</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Consignments which include:</th>
<th>Beta emitters, gamma emitters, and low toxicity alpha emitters</th>
<th>Alpha emitters — other than those of low toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) excepted packages of radioactive material;</td>
<td>0.4 Bq/cm²</td>
<td>0.04 Bq/cm²</td>
</tr>
<tr>
<td>(ii) non-radioactive goods; or</td>
<td>(10⁻⁵ μCi/cm²)</td>
<td>(10⁻⁶ μCi/cm²)</td>
</tr>
<tr>
<td>(iii) both</td>
<td>4 Bq/cm²</td>
<td>0.4 Bq/cm²</td>
</tr>
<tr>
<td>Other consignments</td>
<td>(10⁻⁴ μCi/cm²)</td>
<td>(10⁻⁵ μCi/cm²)</td>
</tr>
</tbody>
</table>

This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
5. DECONTAMINATION AND USE OF CONVEYANCES, EQUIPMENT OR PARTS THEREOF

(a) Conveyances, equipment or parts thereof which have become contaminated above the limits in Table 7.1, or which show a surface radiation level in excess of 5 $\mu$Sv/h (0.5 mrem/h) in the course of transport of LSA-III material, shall be decontaminated as soon as possible, and in any case before reuse, to levels not exceeding those specified in Table 7.1, and so that the resulting surface radiation level after decontamination does not exceed 5 $\mu$Sv/h (0.5 mrem/h).
414  (b) A conveyance dedicated to the transport of LSA-III material under exclusive use may be excepted from (a) above solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use.

6. MIXED CONTENTS OF PACKAGES

Other items may be transported in the packaging with LSA-III material, provided there is no interaction between the other items and the LSA-III material or its packaging which would reduce the safety of the package.

7. MIXED LOADING

(a) Mixing of packages of different kinds of radioactive material, including fissile material, and mixing of packages with different transport indexes (TIs) is permitted.

(b) Consignments shall be segregated from other dangerous goods in compliance with the relevant transport regulations. If the consignment is transported under exclusive use the carriage of other goods is permitted provided the arrangements are controlled only by the consignor and it is not prohibited by other regulations.

(c) Radioactive material shall be segregated from undeveloped photographic film so that the radiation exposure of film due to the transport of radioactive material is limited to 0.1 mSv (10 mrem) per consignment of such film.

8. LABELLING AND MARKING OF PACKAGES, FREIGHT CONTAINERS AND OVERPACKS

The following requirements apply to packages, freight containers and overpacks containing LSA-III non-fissile material.
A surface contaminated object (SCO) is a solid object which is not itself radioactive but which has radioactive material distributed on its surfaces. There are two groups, SCO-I and SCO-II, which differ in the maximum level of contamination permitted. If fissile material is present the requirements of Schedule 12 shall be met in addition to the requirements summarized in this Schedule.

1. MATERIALS

A solid, non-radioactive object, which has radioactive material distributed on its surfaces, may be classified as SCO-I or SCO-II when the fixed and non-fixed surface contamination levels, averaged over 300 cm² (or the area of the surface if less than 300 cm²), do not exceed the limits specified in Table 8.1.

2. PACKAGING/PACKAGE

(a) SCO-I may be transported unpackaged if:

425(a) (i) it is transported in such a manner that, in routine transport, there will be no escape of contents from the conveyance and no loss of shielding; and

425(b), 425(c) (ii) for SCO-I, where it is suspected that non-fixed contamination exists on inaccessible surfaces in excess of 4 Bq/cm² ($10^{-4}$ μCi/cm²) for beta and gamma emitters and low toxicity alpha emitters, or 0.4 Bq/cm² ($10^{-5}$ μCi/cm²) for all other alpha emitters, measures are taken to ensure that the radioactive material is not released into the conveyance and it is transported under exclusive use.

* Information given in the left margin refers to paragraph numbers, tables and/or figures in the 1985 Edition of Safety Series No. 6, including the 1986 Supplement to Safety Series No. 6.
### TABLE 8.1. SURFACE CONTAMINATION LIMITS FOR SCO-I AND SCO-II

<table>
<thead>
<tr>
<th>Type of contamination</th>
<th>Type of emitters</th>
<th>SCO-I Non-fixed on accessible surface</th>
<th>SCO-I Fixed on accessible surface</th>
<th>SCO-I Sum of fixed and non-fixed on the inaccessible surface</th>
<th>SCO-II Non-fixed on accessible surface</th>
<th>SCO-II Fixed on accessible surface</th>
<th>SCO-II Sum of fixed and non-fixed on the inaccessible surface</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4 Bq/cm² (10⁻⁴ μCi/cm²)</td>
<td>4 × 10⁴ Bq/cm² (1 μCi/cm²)</td>
<td>4 × 10⁴ Bq/cm² (1 μCi/cm²)</td>
<td>400 Bq/cm² (10⁻² μCi/cm²)</td>
<td>8 × 10⁵ Bq/cm² (20 μCi/cm²)</td>
<td>8 × 10⁵ Bq/cm² (20 μCi/cm²)</td>
</tr>
<tr>
<td>Beta/gamma emitters</td>
<td>and low toxicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>alpha emitters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All other alpha</td>
<td></td>
<td>0.4 Bq/cm² (10⁻⁵ μCi/cm²)</td>
<td>4 × 10³ Bq/cm² (0.1 μCi/cm²)</td>
<td>4 × 10³ Bq/cm² (0.1 μCi/cm²)</td>
<td>40 Bq/cm² (10⁻³ μCi/cm²)</td>
<td>8 × 10⁴ Bq/cm² (2 μCi/cm²)</td>
<td>8 × 10⁴ Bq/cm² (2 μCi/cm²)</td>
</tr>
<tr>
<td>emitters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>426 (b) SCO-II shall</td>
<td>not be transported unpackaged.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>426, 518, 519, Table V (c) Packaged SCO may be transported when:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) the <strong>packaging</strong>, which may be a <strong>freight container</strong>, meets the design requirements for <strong>industrial packages</strong> IP-I (para. 518 of the Regulations) for SCO-I, or IP-2 (para. 519 of the Regulations) for SCO-II; and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) the material is loaded into the <strong>packaging</strong> so that, in routine transport, there will be no escape of contents and no loss of shielding.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>559 (d) SCO which contains <strong>fissile material</strong> shall, in addition, meet the requirements for <strong>packages</strong> containing <strong>fissile material</strong> (see Schedule 12).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>105, 407 (e) Other dangerous properties shall be taken into account so as to comply with the relevant transport regulations for dangerous goods.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. CONTAMINATION ON PACKAGES, FREIGHT CONTAINERS AND OVERPACKS

(a) Non-fixed contamination on the external surfaces of IP-1 or IP-2 packages and on the internal and external surfaces of freight containers and overpacks used for transporting IP-1 or IP-2 packages shall be kept as low as practicable and shall not exceed the limits specified in Table 8.2.

(b) Overpacks or freight containers dedicated to the transport of SCO-I or SCO-II under exclusive use may be excepted from (a) above solely with regard to their internal surfaces and only for as long as they remain under that exclusive use.

TABLE 8.2. NON-FIXED CONTAMINATION LIMITS

<table>
<thead>
<tr>
<th>Consignments which include:</th>
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<tr>
<td></td>
<td>(10^{-4} \mu Ci/cm²)</td>
<td>(10^{-5} \mu Ci/cm²)</td>
</tr>
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</table>

5. DECONTAMINATION AND USE OF CONVEYANCES, EQUIPMENT OR PARTS THEREOF

(a) Conveyances, equipment or parts thereof which have become contaminated above the limits in Table 8.2, or which show a surface radiation level in excess of 5 \mu Sv/h (0.5 mrem/h) in the course of transport of SCO-I or SCO-II, shall be decontaminated as soon as possible, and in any case before reuse, to levels not exceeding those specified in Table 8.2, and so that the resulting surface radiation level after decontamination does not exceed 5 \mu Sv/h (0.5 mrem/h).
(b) A conveyance dedicated to the transport of SCO under exclusive use may be excepted from (a) above solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use.
6. MIXED CONTENTS OF PACKAGES

Other items may be transported in the packaging with SCO, provided there is no interaction between the other items and the SCO or its packaging which would reduce the safety of the package.

7. MIXED LOADING

(a) Mixing of packages of different kinds of radioactive material, including fissile material, and mixing of packages with different transport indexes (TIs) is permitted.

(b) Consignments shall be segregated from other dangerous goods in compliance with the relevant transport regulations. If the consignment is transported under exclusive use the carriage of other goods is permitted provided the arrangements are controlled only by the consignor and it is not prohibited by other regulations.

(c) Radioactive material shall be segregated from undeveloped photographic film so that the radiation exposure of film due to the transport of radioactive material is limited to 0.1 mSv (10 mrem) per consignment of such film.

8. LABELLING AND MARKING OF PACKAGES, FREIGHT CONTAINERS AND OVERPACKS

The following requirements apply to packages, freight containers and overpacks containing SCO which includes non-fissile material.

For packages, which may be freight containers, containing SCO which includes fissile material, and for freight containers and overpacks carrying packages containing SCO which includes fissile material, see, in addition, Schedule 12.

Any labels which do not relate to the contents shall be removed or covered.

(a) Packages

(i) Completed WHITE or YELLOW labels (see Figs 2, 3 or 4 of the Regulations, as appropriate) with the contents described with the name of the radionuclide, or for mixtures the names of the most restrictive nuclides,
(c) The surface radiation levels for Type A packages, transported under exclusive use by rail or road, may only exceed 2 mSv/h (200 mrem/h) provided that:

(i) the vehicle is equipped with an enclosure which prevents unauthorized access during transport;
(ii) the package or overpack is secured to retain its position within the enclosure during routine transport; and
(iii) there are no loading or unloading operations between the beginning and end of the shipment.

(d) The surface radiation levels for Type A packages, transported by a vessel, may only exceed 2 mSv/h (200 mrem/h) provided that either:

(i) they are transported by the vessel in or on a rail or road vehicle which itself is being transported under exclusive use, or
(ii) they are transported under special arrangement.

(e) The surface radiation levels for Type A packages, transported by air, may only exceed 2 mSv/h (200 mrem/h) provided they are transported under special arrangement.

4. CONTAMINATION ON PACKAGES, FREIGHT CONTAINERS AND OVERPACKS

Non-fixed contamination on the external surfaces of Type A packages and on the internal and external surfaces of freight containers and overpacks used for transporting Type A packages shall be kept as low as practicable and shall not exceed the limits specified in Table 9.1.
## TABLE 9.1. NON-FIXED CONTAMINATION LIMITS

<table>
<thead>
<tr>
<th>Consignments which include:</th>
<th>Beta emitters, gamma emitters, and low toxicity alpha emitters</th>
<th>Alpha emitters — other than those of low toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) excepted packages of radioactive material; (ii) non-radioactive goods; or (iii) both</td>
<td>0.4 Bq/cm² [(10^{-5} \mu Ci/cm^2)]</td>
<td>0.04 Bq/cm² [(10^{-6} \mu Ci/cm^2)]</td>
</tr>
<tr>
<td>Other consignments</td>
<td>4 Bq/cm² [(10^{-4} \mu Ci/cm^2)]</td>
<td>0.4 Bq/cm² [(10^{-5} \mu Ci/cm^2)]</td>
</tr>
</tbody>
</table>

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5. DECONTAMINATION AND USE OF CONVEYANCES, EQUIPMENT OR PARTS THEREOF

413 (a) Conveyances, equipment or parts thereof which have become contaminated above the limits in Table 9.1, or which show a surface radiation level in excess of 5 \( \mu \text{Sv/h} \) (0.5 mrem/h) shall be decontaminated as soon as possible, and in any case before reuse, to levels not exceeding those specified in Table 9.1, and so that the resulting surface radiation level after decontamination does not exceed 5 \( \mu \text{Sv/h} \) (0.5 mrem/h).

145, 404 (b) Tanks, qualified as Type A packagings, used for the transport of radioactive material shall not be used for the storage or transport of other goods.

6. MIXED CONTENTS OF PACKAGES

403 (a) Only articles or documents which are necessary for the use of the radioactive material are permitted in the package provided that there is no interaction between them and the packaging or its contents that would reduce the safety of the package.

403 (b) Other items may not be transported in Type A packaging.

7. MIXED LOADING

464, 465, Table XI (a) Mixing of packages of different kinds of radioactive material, including fissile material, and mixing of packages with different transport indexes (TIs) is permitted.

405, 406, 463 (b) Consignments shall be segregated from other dangerous goods in compliance with the relevant transport regulations. If the consignment is transported under exclusive use the carriage of other goods is permitted provided the arrangements are controlled only by the consignor and it is not prohibited by other regulations.
(ii) it will be capable of withstanding the damaging effects of a serious transport accident as demonstrated by retaining containment and shielding integrity to the extent required by the Regulations when subjected to the accident damage tests specified in the Regulations, and

(iii) If the contents are irradiated fuel with activity greater than 40 PBq ($10^6$ Ci), there would be no rupture of the containment system, if the package were subjected to the water immersion test specified in para. 630.

(c) Approval of the design of Type B(U) packages which do not contain fissile material is required by the competent authority of the country of origin of the design (unilateral approval).

(d) Approval of the design of Type B(U) packages which do contain fissile material is required both by the competent authority of the country of origin of the design and of each country through or into which the packages are transported (multilateral approval).

(e) Type B(U) packages containing fissile material shall, in addition, meet the requirements for packages containing fissile material (see Schedule 12).

(f) Existing packaging manufactured to a design approved by the competent authority as a Type B(U) package under the 1967 Edition of the Regulations may continue to be used, subject to multilateral approval.

(g) Packaging manufactured to a design approved by the competent authority as a Type B(U) package under the 1973 Revised Edition or the 1973 Revised Edition (As Amended) of the Regulations may continue to be used until 31 December 1990. After that date, use of such packaging is subject to multilateral approval and serial numbers shall then be marked on the outside of each packaging.

(h) If the radioactive contents are special form radioactive material, the activity exceeds the $A_2$ activity limit, and credit is taken for the special form nature of the contents in the design, competent authority approval of the design for the special form radioactive material is required.

(i) The smallest overall external dimension of the Type B(U) package shall not be less than 10 cm.
475 (e) The surface radiation levels for Type B(U) packages, transported by air, may only exceed 2 mSv/h (200 mrem/h) provided they are transported under special arrangement.

4. CONTAMINATION ON PACKAGES, FREIGHT CONTAINERS, TANKS AND OVERPACKS

Non-fixed contamination on the external surfaces of Type B(U) packages and on the internal and external surfaces of freight containers and overpacks used for transporting Type B(U) packages shall be kept as low as practicable and shall not exceed the limits specified in Table 10.1.

TABLE 10.1. NON-FIXED CONTAMINATION LIMITS

<table>
<thead>
<tr>
<th>Consignments which include:</th>
<th>Beta emitters, gamma emitters, and low toxicity alpha emitters</th>
<th>Alpha emitters — other than those of low toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) excepted packages of radioactive material;</td>
<td>0.4 Bq/cm² ((10^{-5} \mu Ci/cm^2))</td>
<td>0.04 Bq/cm² ((10^{-6} \mu Ci/cm^2))</td>
</tr>
<tr>
<td>(ii) non-radioactive goods;</td>
<td>or</td>
<td></td>
</tr>
<tr>
<td>(iii) both</td>
<td>Other consignments</td>
<td>4 Bq/cm² ((10^{-4} \mu Ci/cm^2))</td>
</tr>
</tbody>
</table>

5. DECONTAMINATION AND USE OF CONVEYANCES, EQUIPMENT OR PARTS THEREOF

(a) Conveyances, equipment or parts thereof which have become contaminated above the limits in Table 10.1, or which show a surface radiation level in excess of 5 μSv/h (0.5 mrem/h) shall be decontaminated as soon as possible, and in any case before reuse, to levels not exceeding those specified in Table 10.1, and so that the resulting surface radiation level after decontamination does not exceed 5 μSv/h (0.5 mrem/h).

(b) Tanks, qualified as Type B(U) packagings, used for the transport of radioactive material shall not be used for the storage or transport of other goods.
6. **MIXED CONTENTS OF PACKAGES**

(a) Only articles or documents which are necessary for the use of the radioactive material are permitted in the package provided that there is no interaction between them and the packaging or its contents that would reduce the safety of the package.

(b) Other items may not be transported in Type B(U) packaging.

7. **MIXED LOADING**

(a) Mixing of packages of different kinds of radioactive material, including fissile material, and mixing of packages with different transport indexes (TIs) is permitted.

(b) Consignments shall be segregated from other dangerous goods in compliance with the relevant transport regulations. If the consignment is transported under exclusive use the carriage of other goods is permitted provided the arrangements are controlled only by the consignor and it is not prohibited by other regulations.

(c) Radioactive material shall be segregated from undeveloped photographic film so that the radiation exposure of film due to the transport of radioactive material is limited to 0.1 mSv (10 mrem) per consignment of such film.

8. **LABELLING AND MARKING OF PACKAGES, FREIGHT CONTAINERS, TANKS AND OVERPACKS**

The following requirements apply to Type B(U) packages containing non-fissile material, and to freight containers and overpacks carrying Type B(U) packages containing non-fissile material.

For Type B(U) packages, which may be freight containers and tanks, containing fissile material, and for freight containers and overpacks carrying Type B(U) packages which themselves contain fissile material, see, in addition, Schedule 12.

Any labels which do not relate to the contents shall be removed or covered.
4. CONTAMINATION ON PACKAGES, FREIGHT CONTAINERS, TANKS AND OVERPACKS

Non-fixed contamination on the external surfaces of Type B(M) packages and on the internal and external surfaces of freight containers and overpacks used for transporting Type B(M) packages shall be kept as low as practicable and shall not exceed the limits specified in Table 11.1.

TABLE 11.1. NON-FIXED CONTAMINATION LIMITS

<table>
<thead>
<tr>
<th>Table III</th>
<th>Beta emitters, gamma emitters, and low toxicity alpha emitters</th>
<th>Alpha emitters — other than those of low toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consignments which include:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) excepted packages of radioactive material;</td>
<td>0.4 Bq/cm²</td>
<td>0.04 Bq/cm²</td>
</tr>
<tr>
<td>(ii) non-radioactive goods; or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iii) both</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other consignments</td>
<td>4 Bq/cm²</td>
<td>0.4 Bq/cm²</td>
</tr>
</tbody>
</table>
5. **DECONTAMINATION AND USE OF CONVEYANCES, EQUIPMENT OR PARTS THEREOF**

(a) Conveyances, equipment or parts thereof which have become contaminated above the limits in Table 11.1, or which show a surface radiation level in excess of 5 $\mu$Sv/h (0.5 mrem/h) shall be decontaminated as soon as possible, and in any case before reuse, to levels not exceeding those specified in Table 11.1, and so that the resulting surface radiation level after decontamination does not exceed 5 $\mu$Sv/h (0.5 mrem/h).
SCHEDULE 11

(ii) if for any other use, for non-fixed contamination, one-tenth of the limits specified in Table 11.1; and
(iii) for fixed contamination, a surface radiation level of 5 \( \mu \text{Sv/h} \) (0.5 mrem/h).

(b) Tanks, qualified as Type B(M) packagings, used for the transport of radioactive material shall not be used for the storage or transport of other goods.

6. MIXED CONTENTS OF PACKAGES

(a) Only articles or documents which are necessary for the use of the radioactive material are permitted in the package provided that there is no interaction between them and the packaging or its contents that would reduce the safety of the package.

(b) Other items may not be transported in Type B(M) packaging.

7. MIXED LOADING

(a) Mixing of packages of different kinds of radioactive material, including fissile material, and mixing of packages with different transport indexes (TIs) is permitted.

(b) Consignments shall be segregated from other dangerous goods in compliance with the relevant transport regulations. If the consignment is transported under exclusive use the carriage of other goods is permitted provided the arrangements are controlled only by the consignor and it is not prohibited by other regulations.

(c) Radioactive material shall be segregated from undeveloped photographic film so that the radiation exposure of film due to the transport of radioactive material is limited to 0.1 mSv (10 mrem) per consignment of such film.

8. LABELLING AND MARKING OF PACKAGES, FREIGHT CONTAINERS, TANKS AND OVERPACKS

The following requirements apply to Type B(M) packages containing non-fissile material, and to freight containers and overpacks carrying Type B(M) packages containing non-fissile material.
SCHEDULE 12

(e) Existing packaging manufactured to a design approved by the competent authority as a package for fissile material under the 1967 Edition of the Regulations may continue to be used, subject to multilateral approval.

(f) Packaging manufactured to a design approved by the competent authority as a package for fissile material under the 1973 Revised Edition or the 1973 Revised Edition (As Amended) of the Regulations may continue to be used until 31 December 1990. After that date, use of such packaging is subject to multilateral approval, and serial numbers shall then be marked on the outside of each packaging.

3. MAXIMUM RADIATION LEVELS

See appropriate Schedule.

4. CONTAMINATION ON PACKAGES

See appropriate Schedule.

5. DECONTAMINATION AND USE OF CONVEYANCES, EQUIPMENT OR PARTS THEREOF

See appropriate Schedule.

6. MIXED CONTENTS OF PACKAGES

Only articles or documents which are necessary for the use of the radioactive material are permitted in the package provided that there is no interaction between them and the packaging or its contents that would reduce the safety (including nuclear criticality safety) of the package.

7. MIXED LOADING

(a) Mixing of packages of different kinds of radioactive material, including fissile material, and mixing of packages with different transport indexes (TIs) is permitted.

(b) Consignments shall be segregated from other dangerous goods in compliance with the relevant transport regulations. If the
FISSILE MATERIAL

consignment is transported under exclusive use the carriage of other goods is permitted provided the arrangements are controlled only by the consignor and it is not prohibited by other regulations.

206 (c) Radioactive material shall be segregated from undeveloped photographic film so that the radiation exposure of film due to the transport of radioactive material is limited to 0.1 mSv (10 mrem) per consignment of such film.

8. LABELLING AND MARKING OF PACKAGES, FREIGHT CONTAINERS, TANKS AND OVERPACKS

(a) Packages

440, 441 (i) Packages of fissile material may be freight containers and tanks if they qualify as packages. Completed WHITE or YELLOW labels (see Figs 2, 3 or 4 of the Regulations, as appropriate) shall be affixed externally to two opposite sides of packages and to all four sides of freight containers and tanks when being used as packages;

(ii) Packages shall be legibly and durably marked externally with:

438, 725 — "TYPE A", "TYPE B(U)" or "TYPE B(M)" if appropriate;

425(b), 438 — competent authority(ies) identification mark(s);

436 — the permissible gross mass of the package, if over 50 kg;

407 (iii) Packages containing material having additional dangerous properties (e.g. uranium hexafluoride) shall also be labelled as required by the relevant transport regulations.

(iv) For additional marking and labelling requirements, see appropriate Schedule.

(b) Freight containers and overpacks

440, 441 (i) Completed WHITE or YELLOW labels (see Figs 2, 3 or 4 of the Regulations, as appropriate) shall be affixed externally to all four sides of freight containers, or to two opposite sides of overpacks.

(ii) For additional labelling requirements see appropriate Schedule.
145, 404  

(b) Tanks used for the transport of radioactive material shall not be used for the storage or transport of other goods.

6. MIXED CONTENTS OF PACKAGES

As allowed by the competent authorities approval certificates for special arrangement.

7. MIXED LOADING

464  

(a) A shipment under special arrangement may be mixed with other shipments of radioactive material only if specifically authorized by the competent authorities.

405, 406, 463  

(b) Consignments shall be segregated from other dangerous goods in compliance with the relevant transport regulations. If the consignment is transported under exclusive use the carriage of other goods is permitted provided the arrangements are controlled only by the consignor and it is not prohibited by other regulations.

206  

(c) Radioactive material shall be segregated from undeveloped photographic film so that the radiation exposure of film due to the transport of radioactive material is limited to 0.1 mSv (10 mrem) per consignment of such film.

8. LABELLING AND MARKING OF PACKAGES, FREIGHT CONTAINERS, TANKS AND OVERPACKS

440  

Any labels which do not relate to the contents shall be removed or covered.

(a) Packages

435, 440, 441, 442(a), 443  

(i) Completed YELLOW-III labels (see Fig. 4 of the Regulations), or enlarged labels (see para. 443), with the contents described with the name of the radionuclide, or for mixtures the names of the most restrictive nuclides, shall be affixed externally to two opposite sides of packages and to all four sides of freight containers and tanks when used as packages.
LIST OF PARTICIPANTS

REVIEW PANEL MEETING

Vienna
22–26 June 1987

Argentina
Biaggio, A.L.

Austria
Neubauer, J.
Kafka, G.

Belgium
Baekelandt, L.

Canada
Joseph, D.
Dicke, G.
Gibson, W.H.
Jackson, B.J.
Pittuck, A.

France
Ringot, C.
Grenier, M.
Hamard, J.

German Democratic Republic
Fasten, C.
Nitsche, F.

Germany, Federal Republic of
Collin, F.W.
Cosack, M.
Ridder, K.

Hungary
Golder, F.

India
Singh, D.

Italy
Faloci, C.
Gioria, G.
Orsini, A.

Japan
Kitamura, T.
Sanui, I.
Shiomi, S.
Yasogawa, Y.

Netherlands
Selling, H.A.
von Oosterwijk, R.
<table>
<thead>
<tr>
<th>Country</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>Pettersson, B.G. (Chairman)</td>
</tr>
<tr>
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<td>Dufva, B.</td>
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<td>Svahn, B.</td>
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<td>Switzerland</td>
<td>Brélaz, P.</td>
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<td>Stalder, F.</td>
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<td>United Kingdom</td>
<td>Blackman, D.J.</td>
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<td>Goldfinch, E.P.</td>
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<td>Jankowski, G.</td>
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<td>Shaw, K.B.</td>
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<td>Young, C.N.</td>
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<tr>
<td>United States of America</td>
<td>Wangler, M.</td>
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<td>Luna, R.E.</td>
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<tr>
<td>Commission of the European Communities</td>
<td>Marchal, M.A.</td>
</tr>
<tr>
<td>International Air Transport Association</td>
<td>Johnson, G.M.</td>
</tr>
<tr>
<td>International Atomic Energy Agency</td>
<td>Levin, I.</td>
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<tr>
<td></td>
<td>O'Sullivan, R.A. (Scientific Secretary)</td>
</tr>
<tr>
<td>International Civil Aviation Organization</td>
<td>Alternos, E.</td>
</tr>
<tr>
<td>International Maritime Organization</td>
<td>Wardelmann, H.</td>
</tr>
</tbody>
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