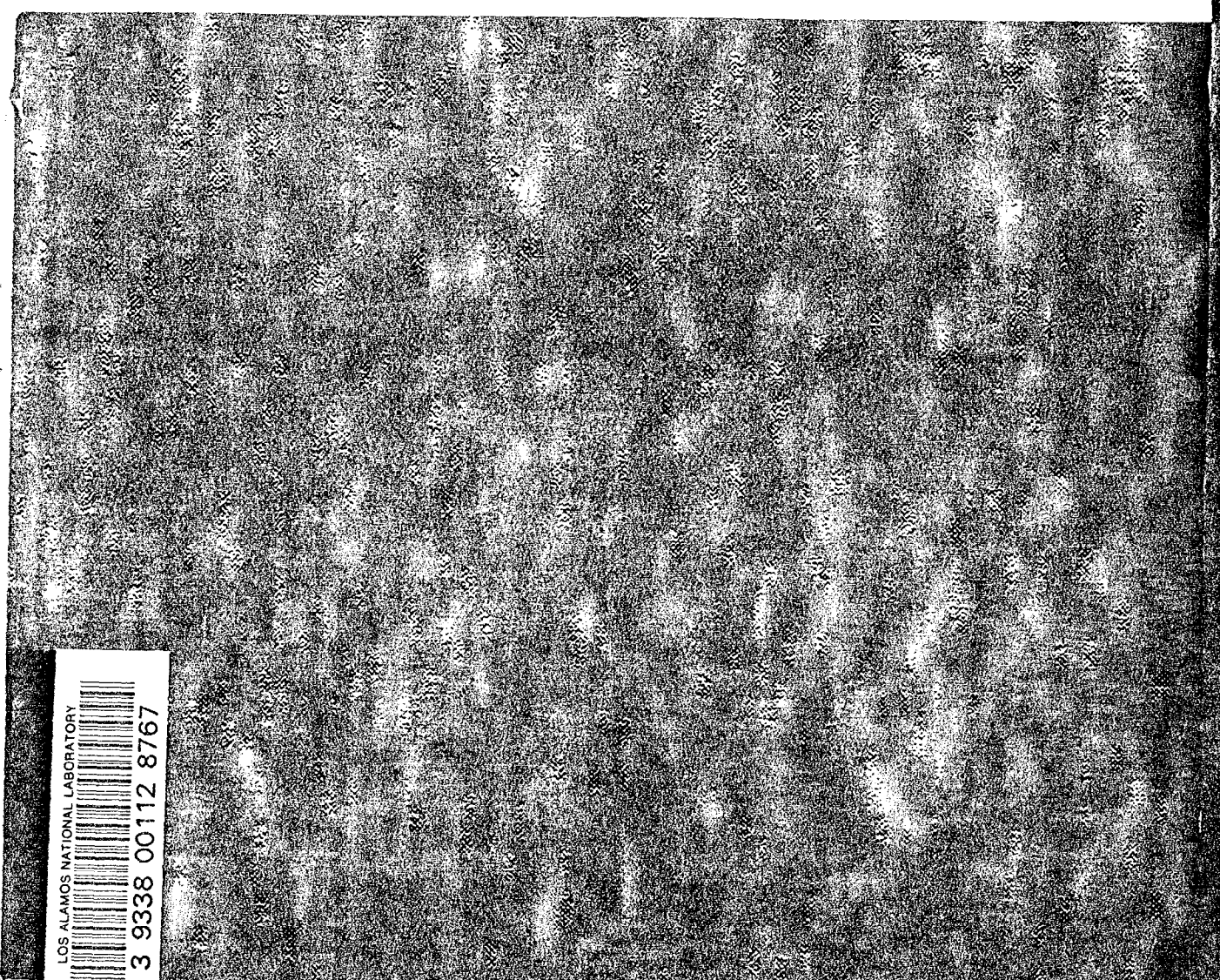
safety series

safety series

No. 6



INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1985

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From Safety Series No. 46 onwards the various publications in the 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.*

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REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIAL

1985 Edition

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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".

Reprinted by the IAEA in Austria
May 1986

SAFETY SERIES No. 6

REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIAL

1985 Edition

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INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 1985

THESE REGULATIONS ARE ALSO PUBLISHED
IN FRENCH, RUSSIAN AND SPANISH

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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.

Concerning radiation protection during transport, the radiation exposure to transport workers and to the general public is subject to the limitations stated in the 'Basic Safety Standards for Radiation Protection, 1982 Edition', Safety Series No.9, jointly sponsored by the International Atomic Energy Agency, the International Labour Organisation, the Nuclear Energy Agency of the OECD and the World Health Organization. The first edition was published in 1962, the second edition in 1967 and the third and current edition in 1982.

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, there-

fore, 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'.

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SECTION I

INTRODUCTION

PURPOSE AND SCOPE

101. The purpose of these Regulations is to establish standards of safety which provide an acceptable level of control of the radiation hazards to persons, property, and the environment that are associated with the transport of radioactive material. Controls instituted for other reasons, such as economics or physical protection, shall not detract from the standards of safety which these Regulations are intended to provide.

102. These Regulations shall apply to the transport of radioactive material other than that which is an integral part of the means of transport, by all modes on land, water, or in the air, including transport which is incidental to the use of the radioactive materials.

103. Transport shall be deemed to comprise all operations and conditions associated with and involved in the movement of radioactive material; these include the design, fabrication and maintenance of packaging, and the preparation, consigning, handling, carriage, storage in transit and receipt at the final destination of packages. Transport includes normal and accident conditions encountered in carriage and in storage during transit.

104. These Regulations do not apply:

(a) within establishments where the radioactive material is produced, used, or stored other than in the course of transport, and in respect of which other appropriate safety regulations are in force, or

(b) to human beings who have been implanted with radioisotopic cardiac pacemakers or other devices, or who have been treated with radiopharmaceuticals.

105. For radioactive material having other dangerous properties, and for transport or storage of radioactive material with other dangerous goods, the relevant transport regulations for dangerous goods of each of the countries through or into which the material is to be transported, and the regulations of the cognizant transport organizations, shall apply, in addition to these Regulations. It is also necessary to take into account the possible formation of products having dangerous properties by interaction of contents with the atmosphere or with water (e.g. the case of UF_6). (See paras 208 and 407.)

106. Taking into account the present levels of safety in the transport of radioactive material, it is not generally necessary to recommend routing restrictions. However,

when such requirements are imposed, account shall be taken of all risks including normal and accident risks, both radiological and non-radiological.

107. In the transport of **radioactive material** public and worker safety is assured when these Regulations are complied with. Confidence in this regard is achieved through **quality assurance** and **compliance assurance** programmes. **Quality assurance** involves plans and actions by designers and manufacturers of **packagings**, and by **consignors**, **carriers** and **competent authorities** to ensure that all requirements applicable to **packages** and **consignment** are properly met **Compliance assurance** involves reviews, inspections and other actions aimed at confirming that the provisions of these Regulations are met in practice.

108. In certain parts of these Regulations, a particular action is prescribed, but the responsibility for carrying out the action is not specifically assigned to any particular person. Such responsibility may vary according to the laws and customs of different countries and the international conventions into which these countries have entered. For the purpose of these Regulations, it is not necessary to make this assignment, but only to identify the action itself. It remains the prerogative of each Government to assign this responsibility.

109. In implementing the provisions of these Regulations, it may be necessary for Member States to issue complementary national regulations. Except as necessary for solely domestic purposes, such national regulations should not conflict with these Regulations.

DEFINITIONS FOR THE PURPOSE OF THESE REGULATIONS

A_1 and A_2

110. A_1 shall mean the maximum activity of **special form radioactive material** permitted in a **Type A package**. A_2 shall mean the maximum activity of **radioactive material**, other than **special form radioactive material**, permitted in a **Type A package**.

Aircraft

111. **Cargo aircraft** shall mean any aircraft, other than a **passenger aircraft**, which is carrying goods or property.

112. **Passenger aircraft** shall mean an aircraft that carries any person other than a crew member, a **carrier's** employee in an official capacity, an authorized representative of an appropriate national authority, or a person accompanying a **consignment**.

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Approval

113. **Multilateral approval** shall mean approval by the relevant **competent authority** both of the country of origin of the **design** or **shipment** and of each country through or into which the **consignment** is to be transported. The term "through or into" specifically excludes "over", i.e. the approval and notification requirements shall not apply to a country over which **radioactive material** is carried in an **aircraft**, provided that there is no scheduled stop in that country.

114. **Unilateral approval** shall mean an approval of a **design** which is required to be given by the **competent authority** of the country of origin of the **design** only.

Carrier

115. **Carrier** shall mean any individual, organization or government undertaking the carriage of **radioactive material** by any means of transport. The term includes both carriers for hire or reward (known as common or contract carriers in some countries) and carriers on own account (known as private carriers in some countries).

Competent authority

116. **Competent authority** shall mean any national or international authority designated or otherwise recognized as such for any purpose in connection with these Regulations.

Compliance assurance

117. **Compliance assurance** shall mean a systematic programme of measures applied by a **competent authority** which is aimed at ensuring that the provisions of these Regulations are met in practice.

Consignee

118. **Consignee** shall mean any individual, organization or government which receives a **consignment**.

Consignment

119. **Consignment** shall mean any **package** or **packages**, or load of **radioactive material**, presented by a **consignor** for transport.

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 Bq/cm^2 (10^{-5} μCi/cm^2) for beta and gamma emitters, or 0.04 Bq/cm^2 (10^{-6} μCi/cm^2) for alpha emitters.

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

description may include specifications, engineering drawings, reports demonstrating compliance with regulatory requirements, and other relevant documentation.

Exclusive use

128. **Exclusive use** shall mean the sole use, by a single **consignor**, of a **conveyance** or of a large **freight container** with a minimum length of 6 m, in respect of which all initial, intermediate, and final loading and unloading is carried out in accordance with the directions of the **consignor** or **consignee**.

Fissile material

129. **Fissile material** shall mean uranium-233, uranium-235, plutonium-238, plutonium-239, plutonium-241, or any combination of these radionuclides. Unirradiated **natural uranium** and **depleted uranium**, and **natural uranium** or **depleted uranium** which has been irradiated in thermal reactors only, are not included in this definition.

Freight container

130. **Freight container** shall mean an article of transport equipment designed to facilitate the carriage of goods, either packaged or unpackaged, by one or more modes of transport without intermediate reloading. It shall be of a permanent enclosed character, rigid and strong enough for repeated use, and must be fitted with devices facilitating its handling, particularly in transfer between **conveyances** and from one mode of transport to another. A small **freight container** is that which has either any overall outer dimension less than 1.5 m, or an internal volume of not more than 3.0 m^3. Any other **freight container** is considered to be a large **freight container**. A **freight container** may be used as a **packaging** if the applicable requirements are met. It may also be used to perform the function of an **overpack**.

Low specific activity material

131. **Low specific activity (LSA) material** shall mean **radioactive material** which by its nature has a limited **specific activity**, or **radioactive material** for which limits of estimated average **specific activity** apply. External shielding materials surrounding the **LSA material** shall not be considered in determining the estimated average **specific activity**.

LSA material shall be in one of three groups:

(a) **LSA-I**

(i) Ores containing naturally occurring radionuclides (e.g. uranium, thorium), and uranium or thorium concentrates of such ores;

(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 1 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 2×10^{-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

paras 515–517 if carried by air, and the Specific Design Requirements in paras 524–540, as appropriate.

(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, and devices for cooling, for absorbing mechanical shocks, and for thermal insulation. 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 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 4 Bq/cm^2 (10^{-4} $\mu Ci/cm^2$) for beta and gamma emitters, or 0.4 Bq/cm^2 (10^{-5} $\mu Ci/cm^2$) for alpha emitters; and

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

(iii) the **non-fixed contamination** plus the **fixed contamination** on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 4×10^4 Bq/cm^2 (1 $\mu Ci/cm^2$) for beta and gamma emitters, or 4×10^3 Bq/cm^2 (0.1 $\mu Ci/cm^2$) for 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 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 400 Bq/cm^2 (10^{-2} $\mu Ci/cm^2$) for beta and gamma emitters or 40 Bq/cm^2 (10^{-3} $\mu Ci/cm^2$) for alpha emitters; and

(ii) the **fixed contamination** on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 8×10^5 Bq/cm^2 (20 $\mu Ci/cm^2$) for beta and gamma emitters or 8×10^4 Bq/cm^2 (2 $\mu Ci/cm^2$) for alpha emitters; and

(iii) the **non-fixed contamination** plus the **fixed contamination** on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 8×10^5 Bq/cm^2 (20 $\mu Ci/cm^2$) for beta and gamma emitters, or 8×10^4 Bq/cm^2 (2 $\mu Ci/cm^2$) for 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 or slurries 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 PRINCIPLES AND PROVISIONS

GENERAL PRINCIPLES FOR 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.

PROVISION FOR AVOIDING RADIATION DAMAGE TO FILM

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.

GENERAL ACCIDENT PROVISIONS

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. UF_6 decomposition in a humid atmosphere.

GENERAL PROVISION FOR QUALITY ASSURANCE PROGRAMME

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 **packagings** 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.

GENERAL PROVISION FOR 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.

GENERAL PROVISION FOR 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.

SECTION III

ACTIVITY AND FISSILE MATERIAL LIMITS

BASIC A_1/A_2 VALUES

301. Values of A_1 and A_2 for individual radionuclides, which are the bases for many activity limits elsewhere in these Regulations, are given in Table I.

DETERMINATION OF A_1 AND A_2

302. For individual radionuclides whose identities are known, but which are not listed in Table I, the determination of the values of A_1 and A_2 shall require competent authority approval or, for international transport, multilateral approval. Alternatively, the values of A_1 and A_2 in Table II may be used without obtaining competent authority approval.

303. In the calculations of A_1 and A_2 for a radionuclide not in Table I, a single radioactive decay chain in which the radionuclides are present in their naturally occurring proportions and in which no daughter nuclide has a half-life either longer than 10 days or longer than that of the parent nuclide shall be considered as a single radionuclide, and the activity to be taken into account and the A_1 or A_2 value to be applied shall be those corresponding to the parent nuclide of that chain. In the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days or greater than that of the parent nuclide, the parent and such daughter nuclides shall be considered as mixtures of different nuclides.

304. For mixtures of radionuclides whose identities and respective activities are known, the following conditions shall apply:

(a) For special form radioactive material:

$$\sum_i \frac{B(i)}{A_1(i)} \text{ less than or equal to } 1$$

(b) For other forms of radioactive material:

$$\sum_i \frac{B(i)}{A_2(i)} \text{ less than or equal to } 1$$

where $B(i)$ is the activity of radionuclide i and $A_1(i)$ and $A_2(i)$ are the A_1 and A_2 values for radionuclide i, respectively.

Text cont. on p. 30.

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
^{225}Ac (b)*	Actinium (89)	0.6	10	1×10^{-2}	2×10^{-1}
^{227}Ac		40	1000	2×10^{-5}	5×10^{-4}
^{228}Ac		0.6	10	0.4	10
^{105}Ag	Silver (47)	2	50	2	50
^{108}Ag^{m}		0.6	10	0.6	10
^{110}Ag^{m}		0.4	10	0.4	10
^{111}Ag		0.6	10	0.5	10
^{26}Al	Aluminium (13)	0.4	10	0.4	10
^{241}Am	Americium (95)	2	50	2×10^{-4}	5×10^{-3}
^{242}Am^{m}		2	50	2×10^{-4}	5×10^{-3}
^{243}Am		2	50	2×10^{-4}	5×10^{-3}
^{37}Ar	Argon (18)	40	1000	40	1000
^{39}Ar		20	500	20	500
^{41}Ar		0.6	10	0.6	10
^{42}Ar (b)		0.2	5	0.2	5
^{72}As	Arsenic (33)	0.2	5	0.2	5
^{73}As		40	1000	40	1000
^{74}As		1	20	0.5	10
^{76}As		0.2	5	0.2	5
^{77}As		20	500	0.5	10
^{211}At	Astatine (85)	30	800	2	50
^{193}Au	Gold (79)	6	100	6	100
^{194}Au		1	20	1	20
^{195}Au		10	200	10	200
^{196}Au		2	50	2	50
^{198}Au		3	80	0.5	10
^{199}Au		10	200	0.9	20
^{131}Ba	Barium (56)	2	50	2	50
^{133}Ba^{m}		10	200	0.9	20
^{133}Ba		3	80	3	80
^{140}Ba (b)		0.4	10	0.4	10
^{7}Be	Beryllium (4)	20	500	20	500
^{10}Be		20	500	0.5	10
^{205}Bi	Bismuth (83)	0.6	10	0.6	10

* Note: (b) indicates a footnote at the end of Table I: this form is used here to avoid confusion with the superscript m.

(cont.)

Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
Bismuth (cont.)	0.3	8	0.3	8
	0.7	10	0.7	10
	0.3	8	3×10^{-2}	8×10^{-1}
	0.6	10	0.5	10
	0.3	8	0.3	8
Berkelium (97)	2	50	2×10^{-4}	5×10^{-3}
	40	1000	8×10^{-2}	2
Bromine (35)	0.3	8	0.3	8
	3	80	3	80
	0.4	10	0.4	10
Carbon (6)	1	20	0.5	10
	40	1000	2	50
Calcium (20)	40	1000	40	1000
	40	1000	0.9	20
	0.9	20	0.5	10
Cadmium (48)	40	1000	1	20
	20	500	9×10^{-2}	2
	0.3	8	0.3	8
	4	100	0.5	10
Cerium (58)	6	100	6	100
	10	200	0.5	10
	0.6	10	0.5	10
	0.2	5	0.2	5
Californium (98)	30	800	3×10^{-3}	8×10^{-2}
	2	50	2×10^{-4}	5×10^{-3}
	5	100	5×10^{-4}	1×10^{-2}
	2	50	2×10^{-4}	5×10^{-3}
	0.1	2	1×10^{-3}	2×10^{-2}
	40	1000	6×10^{-2}	1
	3×10^{-3}	8×10^{-2}	6×10^{-4}	1×10^{-2}
Chlorine (17)	20	500	0.5	10
	0.2	5	0.2	5
Curium (96)	40	1000	2×10^{-2}	5×10^{-1}
	2	50	0.9	20

For footnotes see page 29.

TABLE I. (cont.)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
^{242}Cm	Curium (cont.)	40	1000	1×10^{-2}	2×10^{-1}
^{243}Cm		3	80	3×10^{-4}	8×10^{-3}
^{244}Cm		4	100	4×10^{-4}	1×10^{-2}
^{245}Cm		2	50	2×10^{-4}	5×10^{-3}
^{246}Cm		2	50	2×10^{-4}	5×10^{-3}
^{247}Cm		2	50	2×10^{-4}	5×10^{-3}
^{248}Cm		4×10^{-2}	1	5×10^{-5}	1×10^{-3}
^{55}Co	Cobalt (27)	0.5	10	0.5	10
^{56}Co		0.3	8	0.3	8
^{57}Co		8	200	8	200
$^{58}Co^{m}$		40	1000	40	1000
^{58}Co		1	20	1	20
^{60}Co		0.4	10	0.4	10
^{51}Cr	Chromium (24)	30	800	30	800
^{129}Cs	Caesium (55)	4	100	4	100
^{131}Cs		40	1000	40	1000
^{132}Cs		1	20	1	20
$^{134}Cs^{m}$		40	1000	9	200
^{134}Cs		0.6	10	0.5	10
^{135}Cs		40	1000	0.9	20
^{136}Cs		0.5	10	0.5	10
^{137}Cs (b)		2	50	0.5	10
^{64}Cu	Copper (29)	5	100	0.9	20
^{67}Cu		9	200	0.9	20
^{159}Dy	Dysprosium (66)	20	500	20	500
^{165}Dy		0.6	10	0.5	10
^{166}Dy (b)		0.3	8	0.3	8
^{169}Er	Erbium (68)	40	1000	0.9	20
^{171}Er		0.6	10	0.5	10
^{147}Eu	Europium (63)	2	50	2	50
^{148}Eu		0.5	10	0.5	10
^{149}Eu		20	500	20	500
^{150}Eu		0.7	10	0.7	10

For footnotes see page 29.

TABLE I. (cont.)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
$^{152}Eu^{m}$	Europium (cont.)	0.6	10	0.5	10
^{152}Eu		0.9	20	0.9	20
^{154}Eu		0.8	20	0.5	10
^{155}Eu		20	500	2	50
^{156}Eu		0.6	10	0.5	10
^{18}F	Fluorine (9)	1	20	0.5	10
^{52}Fe (b)	Iron (26)	0.2	5	0.2	5
^{55}Fe		40	1000	40	1000
^{59}Fe		0.8	20	0.8	20
^{60}Fe		40	1000	0.2	5
^{67}Ga	Gallium (31)	6	100	6	100
^{68}Ga		0.3	8	0.3	8
^{72}Ga		0.4	10	0.4	10
^{146}Gd (b)	Gadolinium (64)	0.4	10	0.4	10
^{153}Gd		10	200	5	100
^{159}Gd		4	100	0.5	10
^{68}Ge (b)	Germanium (32)	0.3	8	0.3	8
^{71}Ge		40	1000	40	1000
^{77}Ge		0.3	8	0.3	8
^{172}Hf (b)	Hafnium (72)	0.5	10	0.3	8
^{175}Hf		3	80	3	80
^{181}Hf		2	50	0.9	20
^{183}Hf		4	100	3×10^{-2}	8×10^{-1}
^{194}Hg (b)	Mercury (80)	1	20	1	20
$^{195}Hg^{m}$		5	100	5	100
$^{197}Hg^{m}$		10	200	0.9	20
^{197}Hg		10	200	10	200
^{203}Hg		4	100	0.9	20
^{163}Ho	Holmium (67)	40	1000	40	1000
$^{166}Ho^{m}$		0.6	10	0.3	8
^{166}Ho		0.3	8	0.3	8
^{123}I	Iodine (53)	6	100	6	100

For footnotes see page 29.

TABLE I. (cont.)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
^{124}I	Iodine (cont.)	0.9	20	0.9	20
^{125}I		20	500	2	50
^{126}I		2	50	0.9	20
^{129}I		Unlimited		Unlimited	
^{131}I		3	80	0.5	10
^{132}I		0.4	10	0.4	10
^{133}I		0.6	10	0.5	10
^{134}I		0.3	8	0.3	8
^{135}I		0.6	10	0.5	10
^{111}In	Indium (49)	2	50	2	50
$^{113}In^m$		4	100	4	100
$^{114}In^m$ (b)		0.3	8	0.3	8
$^{115}In^m$		6	100	0.9	20
^{189}Ir	Iridium (77)	10	200	10	200
^{190}Ir		0.7	10	0.7	10
^{192}Ir		1	20	0.5	10
$^{193}Ir^m$		10	200	10	200
^{194}Ir		0.2	5	0.2	5
^{42}K	Potassium (19)	0.2	5	0.2	5
^{43}K		1	20	0.5	10
^{81}Kr	Krypton (36)	40	1000	40	1000
$^{85}Kr^m$		6	100	6	100
^{85}Kr		20	500	10	200
^{87}Kr		0.2	5	0.2	5
^{137}La	Lanthanum (57)	40	1000	2	50
^{140}La		0.4	10	0.4	10
LSA	Low specific activity material (see para. 131)				
^{172}Lu	Lutetium (71)	0.5	10	0.5	10
^{173}Lu		8	200	8	200
$^{174}Lu^m$		20	500	8	200
^{174}Lu		8	200	4	100
^{177}Lu		30	800	0.9	20

For footnotes see page 29.

TABLE II (cont.)

Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
For Mixed Fission Products, use formula for mixtures or Table II				
Magnesium (12)	0.2	5	0.2	5
Manganese (25)	0.3	8	0.3	8
	Unlimited		Unlimited	
	1	20	1	20
	0.2	5	0.2	5
Molybdenum (42)	40	1000	7	100
	0.6	10	0.5	10
Nitrogen (7)	0.6	10	0.5	10
Sodium (11)	0.5	10	0.5	10
	0.2	5	0.2	5
Niobium (41)	0.7	10	0.7	10
	40	1000	6	100
	0.6	10	0.6	10
	1	20	1	20
	0.6	10	0.5	10
Neodymium (60)	4	100	0.5	10
	0.6	10	0.5	10
Nickel (28)	40	1000	40	1000
	40	1000	30	800
	0.3	8	0.3	8
Neptunium (93)	40	1000	40	1000
	7	100	1×10^{-3}	2×10^{-2}
	2	50	2×10^{-4}	5×10^{-3}
	6	100	0.5	10
Osmium (76)	1	20	1	20
	40	1000	40	1000
	10	200	0.9	20
	0.6	10	0.5	10
	0.2	5	0.2	5
Phosphorus (15)	0.3	8	0.3	8
	40	1000	0.9	20
Protactinium (91)	2	50	0.1	2

For footnotes see page 29.

TABLE I. (cont.)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
^{231}Pa	Protactinium (cont.)	0.6	10	6×10^{-5}	1×10^{-3}
^{233}Pa		5	100	0.9	20
^{201}Pb	Lead (82)	1	20	1	20
^{202}Pb		40	1000	2	50
^{203}Pb		3	80	3	80
^{205}Pb		Unlimited		Unlimited	
^{210}Pb (b)		0.6	10	9×10^{-3}	2×10^{-1}
^{212}Pb (b)		0.3	8	0.3	8
^{103}Pd	Palladium (46)	40	1000	40	1000
^{107}Pd		Unlimited		Unlimited	
^{109}Pd		0.6	10	0.5	10
^{143}Pm	Promethium (61)	3	80	3	80
^{144}Pm		0.6	10	0.6	10
^{145}Pm		30	800	7	100
^{147}Pm		40	1000	0.9	20
$^{148}Pm^{m}$		0.5	10	0.5	10
^{149}Pm		0.6	10	0.5	10
^{151}Pm		3	80	0.5	10
^{208}Po	Polonium (84)	40	1000	2×10^{-2}	5×10^{-1}
^{209}Po		40	1000	2×10^{-2}	5×10^{-1}
^{210}Po		40	1000	2×10^{-2}	5×10^{-1}
^{142}Pr	Praseodymium (59)	0.2	5	0.2	5
^{143}Pr		4	100	0.5	10
^{188}Pt (b)	Platinum (78)	0.6	10	0.6	10
^{191}Pt		3	80	3	80
$^{193}Pt^{m}$		40	1000	9	200
^{193}Pt		40	1000	40	1000
$^{195}Pt^{m}$		10	200	2	50
$^{197}Pt^{m}$		10	200	0.9	20
^{197}Pt		20	500	0.5	10
^{236}Pu	Plutonium (94)	7	100	7×10^{-4}	1×10^{-2}
^{237}Pu		20	500	20	500
^{238}Pu		2	50	2×10^{-4}	5×10^{-3}

For footnotes see page 29.

TABLE I. (cont.)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
^{239}Pu	Plutonium (cont.)	2	50	2×10^{-4}	5×10^{-3}
^{240}Pu		2	50	2×10^{-4}	5×10^{-3}
^{241}Pu		40	1000	1×10^{-2}	2×10^{-1}
^{242}Pu		2	50	2×10^{-4}	5×10^{-3}
^{244}Pu (b)		0.3	8	2×10^{-4}	5×10^{-3}
^{223}Ra (b)	Radium (88)	0.6	10	3×10^{-2}	8×10^{-1}
^{224}Ra (b)		0.3	8	6×10^{-2}	1
^{225}Ra (b)		0.6	10	2×10^{-2}	5×10^{-1}
^{226}Ra (b)		0.3	8	2×10^{-2}	5×10^{-1}
^{228}Ra (b)		0.6	10	4×10^{-2}	1
^{81}Rb	Rubidium (37)	2	50	0.9	20
^{83}Rb		2	50	2	50
^{84}Rb		1	20	0.9	20
^{86}Rb		0.3	8	0.3	8
^{87}Rb		Unlimited		Unlimited	
Rb (natural)		Unlimited		Unlimited	
^{183}Re	Rhenium (75)	5	100	5	100
$^{184}Re^{m}$		3	80	3	80
^{184}Re		1	20	1	20
^{186}Re		4	100	0.5	10
^{187}Re		Unlimited		Unlimited	
^{188}Re		0.2	5	0.2	5
^{189}Re		4	100	0.5	10
Re (natural)		Unlimited		Unlimited	
^{99}Rh	Rhodium (45)	2	50	2	50
^{101}Rh		4	100	4	100
$^{102}Rh^{m}$		2	50	0.9	20
^{102}Rh		0.5	10	0.5	10
$^{103}Rh^{m}$		40	1000	40	1000
^{105}Rh		10	200	0.9	20
^{222}Rn (b)	Radon (86)	0.2	5	4×10^{-3}	1×10^{-1}
^{97}Ru	Ruthenium (44)	4	100	4	100
^{103}Ru		2	50	0.9	20

For footnotes see page 29.

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
^{105}Ru	Ruthenium (cont.)	0.6	10	0.5	10
^{106}Ru (b)		0.2	5	0.2	5
^{35}S	Sulphur (16)	40	1000	2	50
^{122}Sb	Antimony (51)	0.3	8	0.3	8
^{124}Sb		0.6	10	0.5	10
^{125}Sb		2	50	0.9	20
^{126}Sb		0.4	10	0.4	10
^{44}Sc	Scandium (21)	0.5	10	0.5	10
^{46}Sc		0.5	10	0.5	10
^{47}Sc		9	200	0.9	20
^{48}Sc		0.3	8	0.3	8
SCO	Surface Contaminated Objects (see para. 144)				
^{75}Se	Selenium (34)	3	80	3	80
^{79}Se		40	1000	2	50
^{31}Si	Silicon (14)	0.6	10	0.5	10
^{32}Si		40	1000	0.2	5
^{145}Sm	Samarium (62)	20	500	20	500
^{147}Sm		Unlimited		Unlimited	
^{151}Sm		40	1000	4	100
^{153}Sm		4	100	0.5	10
^{113}Sn (b)	Tin (50)	4	100	4	100
$^{117}Sn^{m}$		6	100	2	50
$^{119}Sn^{m}$		40	1000	40	1000
$^{121}Sn^{m}$		40	1000	0.9	20
^{123}Sn		0.6	10	0.5	10
^{125}Sn		0.2	5	0.2	5
^{126}Sn (b)		0.3	8	0.3	8
^{82}Sr (b)	Strontium (38)	0.2	5	0.2	5
$^{85}Sr^{m}$		5	100	5	100
^{85}Sr		2	50	2	50
$^{87}Sr^{m}$		3	80	3	80
^{89}Sr		0.6	10	0.5	10
^{90}Sr (b)		0.2	5	0.1	2

For footnotes see page 29.

TABLE I. (cont.)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
^{91}Sr	Strontium (cont.)	0.3	8	0.3	8
^{92}Sr (b)		0.2	5	0.2	5
T (all forms)	Tritium (1)	40	1000	40 and, for liquids only, a concentration not greater than 1 TBq/L	1000 and, for liquids only, a concentration not greater than 20 Ci/L
^{178}Ta	Tantalum (73)	1	20	1	20
^{179}Ta		30	800	30	800
^{182}Ta		0.8	20	0.5	10
^{157}Tb	Terbium (65)	40	1000	10	200
^{158}Tb		1	20	0.7	10
^{160}Tb		0.9	20	0.5	10
$^{95}Tc^m$	Technetium (43)	2	50	2	50
$^{96}Tc^m$ (b)		0.4	10	0.4	10
^{96}Tc		0.4	10	0.4	10
$^{97}Tc^m$		40	1000	40	1000
^{97}Tc		Unlimited		Unlimited	
^{98}Tc		0.7	10	0.7	10
$^{99}Tc^m$		8	200	8	200
^{99}Tc		40	1000	0.9	20
^{118}Te (b)	Tellurium (52)	0.2	5	0.2	5
$^{121}Te^m$		5	100	5	100
^{121}Te		2	50	2	50
$^{123}Te^m$		7	100	7	100
$^{125}Te^m$		30	800	9	200
$^{127}Te^m$ (b)		20	500	0.5	10
^{127}Te		20	500	0.5	10
$^{129}Te^m$ (b)		0.6	10	0.5	10
^{129}Te		0.6	10	0.5	10
$^{131}Te^m$		0.7	10	0.5	10
^{132}Te (b)		0.4	10	0.4	10

For footnotes see page 29.

TABLE I. (cont.)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
^{227}Th	Thorium (90)	9	200	1×10^{-2}	2×10^{-1}
^{228}Th (b)		0.3	8	4×10^{-4}	1×10^{-2}
^{229}Th		0.3	8	3×10^{-5}	8×10^{-4}
^{230}Th		2	50	2×10^{-4}	5×10^{-3}
^{231}Th		40	1000	0.9	20
^{232}Th		Unlimited		Unlimited	
^{234}Th (b)		0.2	5	0.2	5
Th (natural)		Unlimited		Unlimited	
^{44}Ti (b)	Titanium (22)	0.5	10	0.2	5
^{200}Tl	Thallium (81)	0.8	20	0.8	20
^{201}Tl		10	200	10	200
^{202}Tl		2	50	2	50
^{204}Tl		4	100	0.5	10
^{167}Tm	Thulium (69)	7	100	7	100
^{168}Tm		0.8	20	0.8	20
^{170}Tm		4	100	0.5	10
^{171}Tm		40	1000	10	200
^{230}U	Uranium (92)	40	1000	1×10^{-2}	2×10^{-1}
^{232}U		3	80	3×10^{-4}	8×10^{-3}
^{233}U		10	200	1×10^{-3}	2×10^{-2}
^{234}U		10	200	1×10^{-3}	2×10^{-2}
^{235}U		Unlimited		Unlimited	
^{236}U		10	200	1×10^{-3}	2×10^{-2}
^{238}U		Unlimited		Unlimited	
U (natural)		Unlimited		Unlimited	
U (enriched 5% or less)		Unlimited		Unlimited	
U (enriched more than 5%)		10	200	1×10^{-3}	2×10^{-2}
U (depleted)		Unlimited		Unlimited	
^{48}V	Vanadium (23)	0.3	8	0.3	8
^{49}V		40	1000	40	1000
^{178}W (b)	Tungsten (74)	1	20	1	20
^{181}W		30	800	30	800
^{185}W		40	1000	0.9	20

For footnotes see page 29.

TABLE I. (cont.)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci) (approx.[a])	A_2 (TBq)	A_2 (Ci) (approx.[a])
^{187}W	Tungsten (cont.)	2	50	0.5	10
^{188}W (b)		0.2	5	0.2	5
^{122}Xe (b)	Xenon (54)	0.2	5	0.2	5
^{123}Xe		0.2	5	0.2	5
^{127}Xe		4	100	4	100
$^{131}Xe^m$		40	1000	40	1000
^{133}Xe		20	500	20	500
^{135}Xe		4	100	4	100
^{87}Y	Yttrium (39)	2	50	2	50
^{88}Y		0.4	10	0.4	10
^{90}Y		0.2	5	0.2	5
$^{91}Y^m$		2	50	2	50
^{91}Y		0.3	8	0.3	8
^{92}Y		0.2	5	0.2	5
^{93}Y		0.2	5	0.2	5
^{169}Yb	Ytterbium (70)	3	80	3	80
^{175}Yb		30	800	0.9	20
^{65}Zn	Zinc (30)	2	50	2	50
$^{69}Zn^m$ (b)		2	50	0.5	10
^{69}Zn		4	100	0.5	10
^{88}Zr	Zirconium (40)	3	80	3	80
^{93}Zr		40	1000	0.2	5
^{95}Zr		1	20	0.9	20
^{97}Zr		0.3	8	0.3	8

[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.

TABLE II. GENERAL VALUES FOR A_1 AND A_2

Contents	A_1		A_2	
	TBq	(Ci)[a]	TBq	(Ci)[a]
Only beta or gamma emitting nuclides are known to be present	0.2	(5)	0.02	(0.5)
Alpha emitting nuclides are known to be present or no relevant data are available	0.1	(2)	2×10^{-5}	(5×10^{-4})

[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:

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

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.

Excepted packages

308. For **radioactive material** other than articles manufactured of **natural uranium, depleted uranium,** or natural thorium, an **excepted package** shall not contain **activities** greater than the following:

(a) Where the **radioactive material** is enclosed in or forms a component part of an instrument or other manufactured article, such as a clock or electronic apparatus, the limits specified in para. 418 for each individual item and each **package,** respectively; and

(b) Where the **radioactive material** is not so enclosed or manufactured, the limits specified in para. 419.

309. For articles manufactured of **natural uranium, depleted uranium,** or natural **thorium,** an **excepted package** may contain any quantity of such material provided **that** the outer surface of the uranium or thorium is enclosed in an inactive sheath **made** of metal or some other substantial substance.

310. For transport by post, the total activity in each **package** shall not exceed one tenth of the relevant limit specified in Table IV (Section IV).

Industrial packages

311. The total activity in a single **package** of **LSA material** or in a single **package of SCO** shall be so restricted that the **radiation level** specified in para. 422 shall **not** be exceeded, and the activity in a single **package** shall also be so restricted **that** the activity limits for a **conveyance** specified in para. 427 shall not be exceeded.

Type A packages

312. Type A packages shall not contain activities greater than the following:

(a) For special form **radioactive material** – A_1; or
(b) For all other **radioactive material** – A_2.

Values for A_1 and A_2 are listed in Tables I and II.

Type B packages

313. Type B packages shall not contain:

(a) Activities greater than those authorized for the **package design,**
(b) Radionuclides different from those authorized for the **package design,** or
(c) Contents in a form, or a physical or chemical state different from those authorized for the **package design,**

as specified in their certificates of approval.

314. All packagings containing fissile material shall comply with the applicable activity limits for packages specified in paras 308–313.

315. Packagings containing fissile material, other than those containing material which comply with the requirements of para. 560, shall not contain:

(a) A mass of fissile material greater than that authorized for the package design,
(b) Any radionuclide or fissile material different from those authorized for the package design, or
(c) Contents in a form or physical or chemical state, or in a spatial arrangement different from those authorized for the package design,

as specified in their certificates of approval.

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/cm^2) (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 that poisoning.

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.

(d) For each **Type B package**, it shall be ensured by examination and/or appropriate tests that all closures, valves, and other openings of the **containment system** through which the **radioactive contents** might escape are properly closed and, where appropriate, sealed in the manner for which the demonstrations of compliance with the requirements of para. 548 were made.

TRANSPORT OF OTHER GOODS

403. **A package** shall not contain any other items except such articles and documents as are necessary for the use of the **radioactive material**. This requirement shall not preclude the transport of **low specific activity material** or **surface contaminated objects** with other items. The transport of such articles and documents in a **package**, or of **low specific activity material** or **surface contaminated objects** with other items may be permitted provided that there is no interaction between them and the **packaging** or its contents that would reduce the safety of the **package**.

404. **Tanks** used for the transport of **radioactive material** shall not be used for the storage or transport of other goods.

405. The carriage of other goods with **consignments** being transported under **exclusive use** shall be permitted provided the arrangements are controlled only by the **consignor** and it is not prohibited by other regulations.

406. **Consignments** shall be segregated from other dangerous goods during transport and storage in compliance with the relevant transport regulations for dangerous goods of each of the countries through or into which the materials will be transported, and, where applicable, with the regulations of the cognizant transport organizations, as well as these Regulations.

OTHER DANGEROUS PROPERTIES OF CONTENTS

407. In addition to the radioactive properties, any other dangerous properties of the contents of the **package**, such as explosiveness, flammability, pyrophoricity, chemical toxicity and corrosiveness, shall be taken into account in the packing, labelling, marking, placarding, storage, and transport in order to be in compliance with the relevant transport regulations for dangerous goods of each of the countries through or into which the materials will be transported, and, where applicable, with the regulations of the cognizant transport organizations, as well as these Regulations.

TABLE III. LIMITS OF NON-FIXED CONTAMINATION ON SURFACES

Type of package, overpack or freight container	Contaminant	
	Maximum permissible level[a] of beta and gamma emitters and low toxicity alpha emitters[b] Bq/cm² (μCi/cm²)	Maximum permissible level[a] of all other alpha emitters Bq/cm² (μCi/cm²)
External surfaces of:		
excepted packages	0.4 (10^{-5})	0.04 (10^{-6})
other than excepted packages	4 (10^{-4})	0.4 (10^{-5})
External and internal surfaces of overpacks and freight containers when carrying:		
excepted packages	0.4 (10^{-5})	0.04 (10^{-6})
other than excepted packages	4 (10^{-4})	0.4 (10^{-5})

[a] The levels are permissible when averaged over any area of 300 cm² of any part of the surface.

[b] Low toxicity alpha emitters: natural uranium; depleted uranium; natural thorium; uranium-235 or uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores and physical or chemical concentrates; radionuclides with a half-life of less than 10 days.

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 levels specified in Table III.

409. In the case of overpacks and freight containers, the level of non-fixed contamination on the external or the internal surfaces 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**, equipment, or part thereof which has become contaminated above the limits specified in Table III 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 levels 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. **A conveyance** used for the transport of **low specific activity materials** or **surface contaminated objects** under **exclusive use** shall be excepted from the requirements of para. 413 only for as long as it remains under that specific **exclusive use**.

REQUIREMENTS AND CONTROLS FOR TRANSPORT OF EXCEPTED PACKAGES

415. **Excepted packages** shall be subject only to the following provisions:

(a) The requirements specified in paras 407, 416–421 as applicable, and 447–452;
(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

Physical state of contents	Instruments and articles		Materials
	Item limits[a]	Package limits[a]	Package limits[a]
Solids:			
special form	10^{-2} A_1	A_1	10^{-3} A_1
other forms	10^{-2} A_2	A_2	10^{-3} A_2
Liquids:	10^{-3} A_2	10^{-1} A_2	10^{-4} A_2
Gases:			
tritium	2×10^{-2} A_2	2×10^{-1} A_2	2×10^{-2} A_2
special form	10^{-3} A_1	10^{-2} A_1	10^{-3} A_1
other forms	10^{-3} A_2	10^{-2} A_2	10^{-3} A_2

[a] For mixtures of radionuclides, see paras 304–306. The concentration limit for tritium in liquid form, specified in Table I, does not apply.

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 natural uranium, depleted uranium or 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.

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 AND SCO

422. The quantity of LSA material or SCO in a single package or object or collection of objects, if 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;

TABLE V. INDUSTRIAL PACKAGE INTEGRITY REQUIREMENTS FOR LSA MATERIAL AND SCO

Contents	Industrial package type[a]	
	Exclusive use	Not under exclusive use
LSA-I[b]		
Solid	IP-1	IP-1
Liquid	IP-1	IP-2
LSA-II		
Solid	IP-2	IP-2
Liquid and gas	IP-2	IP-3
LSA-III	IP-2	IP-3
SCO-I[b]	IP-1	IP-1
SCO-II	IP-2	IP-2

[a] See para. 134.
[b] Under the conditions specified in para. 425, **LSA-I material** and **SCO-I** may be transported unpackaged.

(b) Each conveyance shall be under exclusive use, except when only transporting SCO-I on which the contamination on the accessible and the inaccessible surfaces is not greater than ten times the applicable level specified in para. 122; and

(c) For SCO-I where it is suspected that non-fixed contamination exists on inaccessible surfaces in excess of the values specified in para. 144(a)(i) measures shall be taken to ensure that the radioactive material is not released into the conveyance.

426. LSA material and SCO, except as otherwise specified in para. 425, shall be packaged in accordance with the package integrity levels specified in Table V, in such a manner that, under conditions likely to be encountered in routine transport, there will be no escape of contents from packages, nor will there be any loss of shielding afforded by the packaging. LSA-II material, LSA-III material and SCO-II shall not be transported unpackaged.

427. The total activity of LSA material and SCO in any single conveyance shall not exceed the limits shown in Table VI.

TABLE VI. CONVEYANCE ACTIVITY LIMITS FOR LSA MATERIAL AND SCO

Nature of material	Activity limit for conveyances other than by inland water-way[a]	Activity limit for a hold or compartment of an inland water craft[a]
LSA-I	No limit	No limit
LSA-II and **LSA-III** non-combustible solids	No limit	100 A_2
LSA-II and **LSA-III** combustible solids, and all liquids and gases	100 A_2	10 A_2
SCO	100 A_2	10 A_2

[a]The concentration limit for tritium in liquid form, specified in Table I, does not apply.

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 millisievert 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

Size of load[a]	Multiplication factor
size of load ≤ 1 m^2	1
1 m^2 < size of load ≤ 5 m^2	2
5 m^2 < size of load ≤ 20 m^2	3
20 m^2 < size of load	10

[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.

TABLE VIII. DETERMINATION OF TRANSPORT INDEX

Item	Contents	Method of determining transport index (TI)
Packages	Non-fissile material	TI for radiation exposure control
	Fissile material	The larger of the TI for radiation exposure control and the TI for nuclear criticality control
Non-rigid overpacks	Packages	Sum of TI's of all packages contained
Rigid overpacks	Packages	The sum of the TI's of all packages contained, or, for the original consignor, either the TI for radiation exposure control or the sum of the TI's of all packages
Freight containers	Packages or overpacks	Sum of the TI's of all packages and overpacks contained
	LSA material or SCO	Either the sum of the TI's or the larger of the TI for radiation exposure control and the TI for nuclear criticality control
Freight containers under exclusive use	Packages or overpacks	Either the sum of the TI's or the larger of the TI for radiation exposure control and the TI for nuclear criticality control
Tanks	Non-fissile material	TI for radiation exposure control
	Fissile material	The larger of the TI for radiation expoure control and the TI for nuclear criticality control
Unpackaged	LSA-I and SCO-I	The TI for radiation exposure control

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 shall be transported under exclusive use.
(d) If the surface radiation level is greater than 2 mSv/h (200 mrem/h), the package shall be transported under exclusive use and under the provisions of para.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

Conditions		Category
Transport index	Maximum radiation level at any point on external surface	
0	Not more than 0.005 mSv/h (0.5 mrem/h)	I-WHITE
More than 0 but not more than 1	More than 0.005 mSv/h (0.5 mrem/h) but not more than 0.5 mSv/h (50 mrem/h)	II-YELLOW
More than 1 but not more than 10	More than 0.5 mSv/h (50 mrem/h) but not more than 2 mSv/h (200 mrem/h)	III-YELLOW
More than 10	More than 2 mSv/h (200 mrem/h) but not more than 10 mSv/h (1000 mrem/h)	III-YELLOW and also under exclusive use

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

Transport index	Category
0	I-WHITE
TI greater than 0 but less than or equal to 1	II-YELLOW
TI greater than 1	III-YELLOW

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.

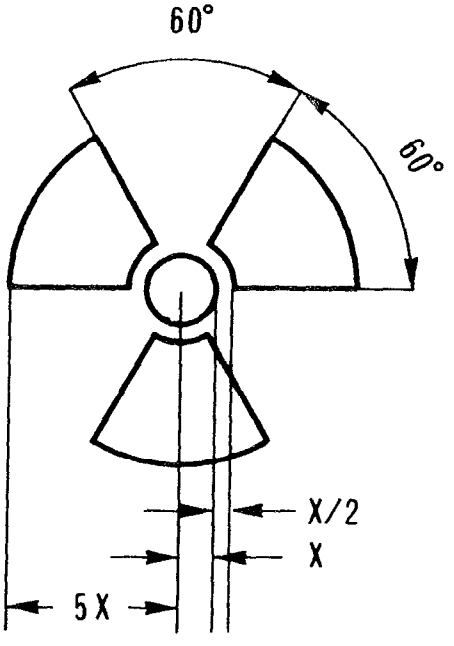

FIG. 1. Basic trefoil symbol with proportions based on a central circle of radius X. The minimum allowable size of X shall be 4 mm.

Labelling

440. Each package, overpack, tank and freight container shall bear the labels which conform to the models in Figs 2, 3 or 4, according to the appropriate category. Any labels which do not relate to the contents shall be removed or covered. For radioactive materials 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.

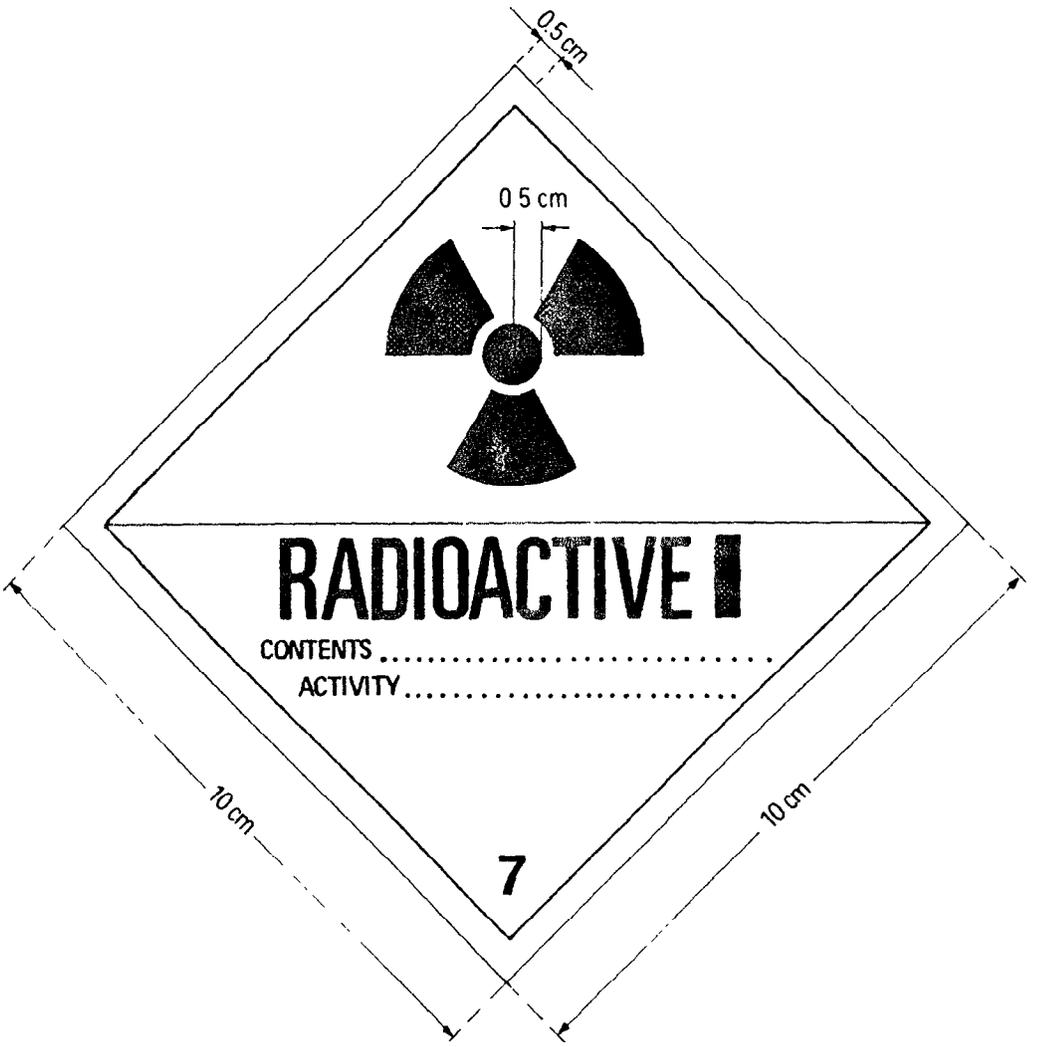

FIG.2. Category I-WHITE label. The background colour of the label shall be white, the colour of the trefoil and the printing shall be black, and the colour of the category bar shall be red.

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

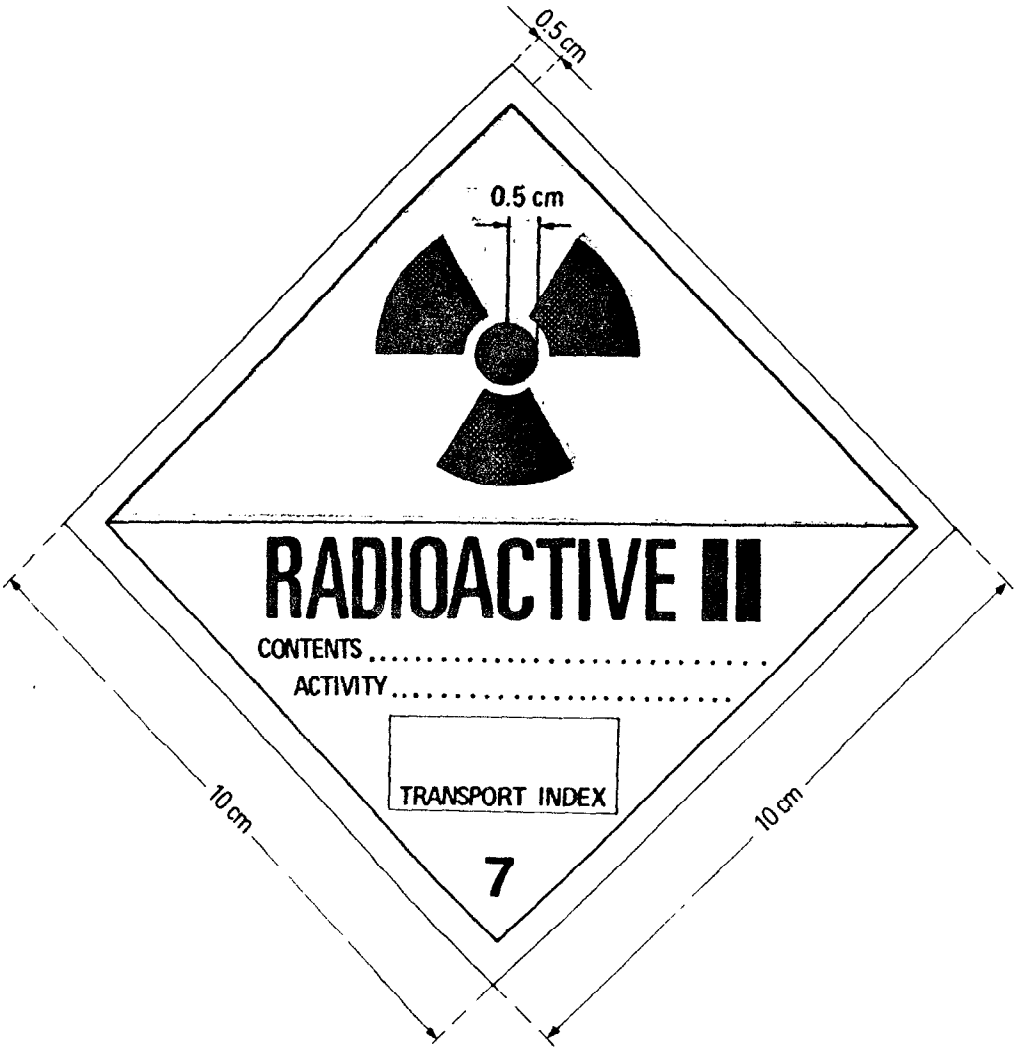

FIG.3. Category II-YELLOW label. The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

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 mass in units of grams (g), or multiples thereof, may be used in place of activity.

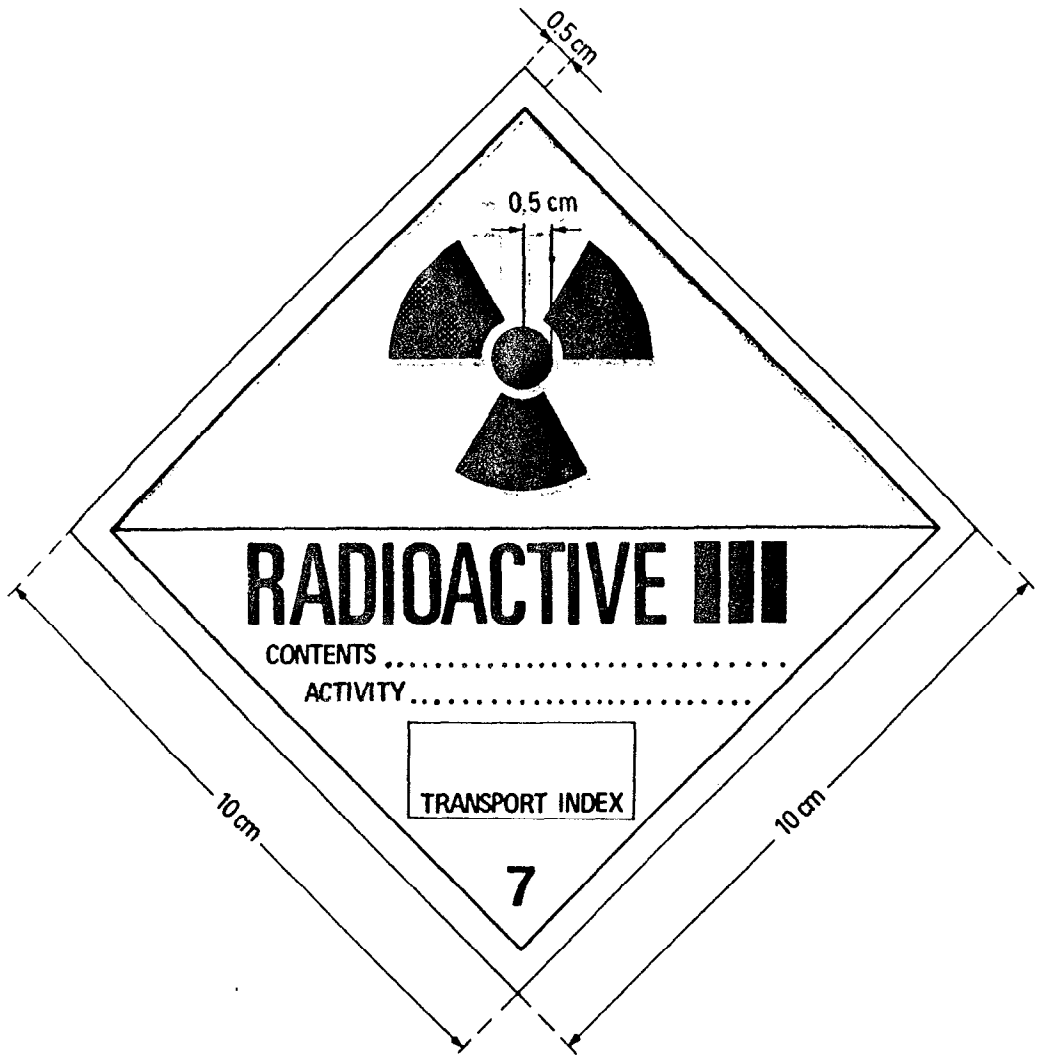

FIG.4. Category III-YELLOW label. The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

(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 radionuclides, such entries may read "See Transport Documents".

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

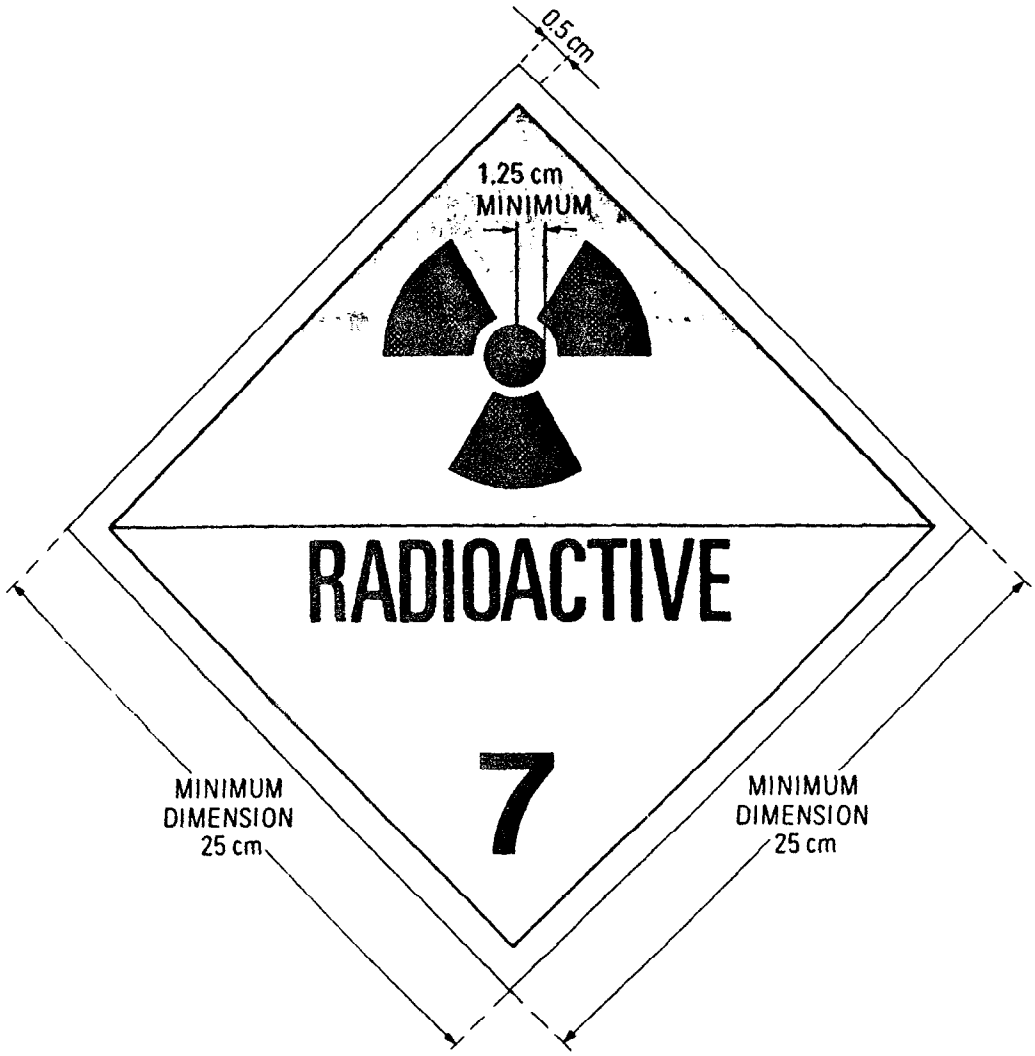

FIG.5. Placard. Minimum dimensions are given; when larger dimensions are used the relative proportions must be maintained. The figure '7' shall not be less than 25 mm high. The background colour of the upper half of the placard shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black. The use of the word "RADIOACTIVE" in the bottom half is optional to allow the alternative use of this placard to display the appropriate United Nations Number for the consignment.

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.

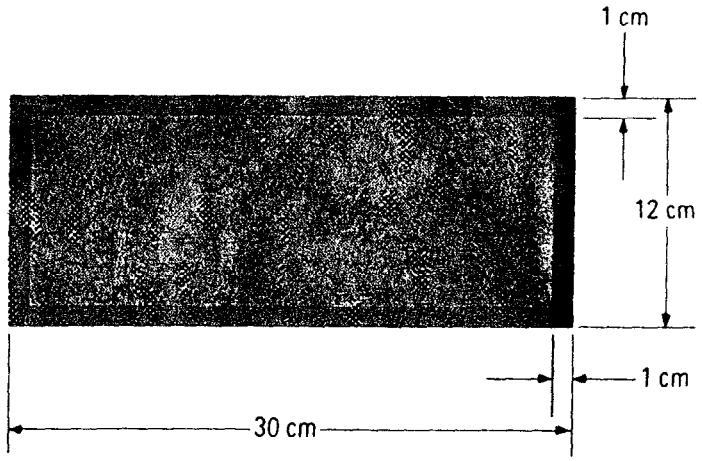

*FIG 6. Placard for separate display of the United Nations Number. The background colour of the placard shall be orange and the border and United Nations Number shall be black. The symbol "****" denotes the space in which the appropriate United Nations Number for* **radioactive material**, *as specified 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. The only inscriptions which shall be mandatory are those shown in these models.

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 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; and
(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.

Consignor's declaration

448. The consignor shall include in the transport documents a declaration in the following terms or in terms having an equivalent meaning:

> "I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packed, marked and labelled, and are in all respects in proper condition for transport by (insert mode(s) of transport involved) according to the applicable international and national governmental regulations."

449. If the intent of the declaration is already a condition of transport within a particular international convention, the consignor need not produce such a declaration for that part of the transport covered by the convention.

450. The declaration shall be signed and dated by the consignor. Facsimile signatures are authorized where applicable laws and regulations recognize the legal validity of facsimile signatures.

451. The declaration shall be made on the same document which contains the particulars of consignment listed in para. 447.

Removal or covering of labels

452. When an empty packaging is shipped as an excepted package under the provisions of para. 421, the previously displayed labels shall not be visible.

Information for carriers

453. The consignor shall provide in the transport documents a statement regarding actions, if any, that are required to be taken by the carrier. The statement shall be in the languages deemed necessary by the carrier or the authorities concerned, and shall include at least the following points:

(a) Supplementary operational requirements for loading, stowage, transport, handling, and unloading of the package, overpack, freight container or tank including any special stowage provisions for the safe dissipation of heat (see para. 463), or a statement that no such requirements are necessary;
(b) Restrictions on the mode of transport or conveyance and any necessary routing instructions;
(c) Emergency arrangements appropriate to the consignment.

454. The applicable competent authority certificates need not necessarily accompany the consignment. The consignor shall, however, be prepared to provide them to the carrier before loading, unloading, and any trans-shipment.

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 3×10^3 A_1 or 3×10^3 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

Type of freight container or conveyance	Limit on total sum of transport indexes in a single freight container or aboard a conveyance			
	Not under exclusive use		Under exclusive use	
	Non-fissile material	Fissile material	Non-fissile material	Fissile material[a]
Freight container – Small	50	50	n.a.	n.a.
Freight container – Large	50	50	No limit	100[b]
Vehicle	50	50	No limit	100[b]
Aircraft				
Passenger	50	50	n.a.	n.a.
Cargo	200	50	No limit	100[b]
Inland water-way vessel	50	50	No limit	100[b]
Seagoing vessel[c]				
1. Hold, compartment or defined deck area:				
Packages, overpacks, small freight containers	50	50	No limit	100[b]
Large freight containers	200[d]	50	No limit	100[b]
2. Total vessel:				
Packages, etc.	200[d]	200[d]	No limit[e]	200[e]
Large freight containers	No limit[d]	No limit[d]	No limit	No limit[d]
3. Special use vessel[f]	n.a.	n.a.	No limit	As approved[f]

[a] Provided that transport is direct from the consignor to the consignee without any intermediate in-transit storage.

[b] In cases in which the total TI is greater than 50, the consignment shall be so handled and stowed 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.

Segregation during transport

460. **Packages, overpacks, freight containers** and **tanks** shall be segregated during transport:

(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.

461. Category II-YELLOW or category III-YELLOW **packages** or **overpacks** shall not be carried in compartments occupied by passengers, except those exclusively reserved for couriers specially authorized to accompany such **packages** or **overpacks**.

Stowing for transport

462. **Consignments** shall be securely stowed.

463. Provided that its average surface heat flux does not exceed 15 W/m^2 and that the immediately surrounding cargo is not in sacks or bags, a **package** or **overpack** may be carried among packaged general cargo without any special stowage provisions except as may be specifically required by the **competent authority** in an applicable approval certificate.

464. Except in the case of **shipment** under **special arrangement**, mixing of **packages** of different kinds of **radioactive material**, including **fissile material**, and mixing of different kinds of **packages** with different **transport indexes** is permitted without specific **competent authority** approval. In the case of **shipments** under **special arrangement** mixing shall not be permitted except as specifically authorized under the **special arrangement**.

465. Loading of **tanks** and **freight containers** and accumulation of **packages**, **overpacks**, **tanks** and **freight containers** shall be controlled as follows:

(a) The total number of **packages**, **overpacks**, **tanks** and **freight containers** aboard a single **conveyance** shall be so limited that the total sum of the **transport indexes** aboard the **conveyance** does not exceed the values shown in Table XI. For consignments of **LSA-I material** there shall be no limit on the sum of the **transport indexes**.
(b) The **radiation level** under conditions likely to be encountered in routine transport shall not exceed 2 mSv/h (200 mrem/h) at any point on, and 0.1 mSv/h (10 mrem/h) at 2 m from, the external surface of the **conveyance**.

466. Any **package** or **overpack** having a **transport index** greater than 10 shall be transported only under **exclusive use**.

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 blackground, 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(a) 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, 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.

479. The number of category II-YELLOW and category III-YELLOW packages, overpacks, tanks and freight containers stored in any one storage area, such as a transit area, terminal building, store-room or assembly yard, shall be so limited that the total sum of the transport indexes in any individual group of such packages, overpacks, tanks or freight containers does not exceed 50. Groups of such packages, overpacks, tanks and freight containers shall be stored so as to maintain a spacing of at least 6 m from other groups of such packages, overpacks, tanks or freight containers.

480. Where the transport index of a single package, overpack, tank or freight container exceeds 50 or the total transport index on board a conveyance exceeds 50, as permitted in Table XI, storage shall be such as to maintain a spacing of at least 6 m from other groups of packages, overpacks, tanks or freight containers or other conveyance carrying radioactive material.

481. Consignments in which the radioactive contents are LSA-I materials shall be excepted from the requirements of paras 479 and 480.

482. Except in the case of shipment under special arrangement, mixing of packages of different kinds of radioactive material, including fissile material, and mixing of different kinds of packages with different transport indexes is permitted without specific competent authority approval. In the case of shipment under special arrangement, mixing shall not be permitted except as specifically authorized under the special arrangement.

CUSTOMS OPERATIONS

483. Customs operations involving examination of the radioactive contents of a package shall be carried out only in a place where adequate means of controlling radiation exposure are provided and in the presence of qualified persons. Any package opened on customs instructions shall, before being forwarded to the consignee, be restored to its original condition.

UNDELIVERABLE PACKAGES

484. In cases where neither the consignor nor the consignee can be identified, the package shall be placed in a safe location and the appropriate competent authority shall be informed as soon as possible, and a request made for instructions on further action.

SECTION V

REQUIREMENTS FOR RADIOACTIVE MATERIALS AND FOR PACKAGINGS AND PACKAGES

REQUIREMENTS FOR RADIOACTIVE MATERIALS

Requirements for LSA-III material

501. **LSA-III material** shall be a solid of such a nature that if the entire contents of a package were subjected to the test specified in para. 603 the activity in the water would not exceed 0.1 A_2.

Requirements for special form radioactive material

502. **Special form radioactive material** shall have at least one dimension not less than 5 mm.

503. **Special form radioactive material** shall be of such nature or shall be so designed that if it is subjected to the tests specified in paras 604–613, it shall meet the following requirements:

(a) It would not break or shatter under the impact, percussion and bending tests in paras 607, 608, 609 and 611(a) as applicable;

(b) It would not melt or disperse in the heat test in para. 610 and para 611(b) as applicable, and

(c) The activity in the water from the leaching tests specified in paras 612 and 613 would not exceed 2 kBq (50 nCi); or alternatively for sealed sources, the leakage rate for the volumetric leakage assessment test specified in the International Organization for Standardization document ISO/TR 4826-1979(E), Sealed Radioactive Sources – Leak Test Methods, would not exceed the applicable acceptance threshold acceptable to the competent authority.

504. When a sealed capsule constitutes part of the special form radioactive material, the capsule shall be so constructed that it can be opened only by destroying it.

GENERAL REQUIREMENTS FOR ALL PACKAGINGS AND PACKAGES

505. The package shall be so designed in relation to its mass, volume and shape that it can be easily and safely handled and transported. In addition, the

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, see para. 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°C to +55°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, 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;

(b) They shall be designed to conform to the standards prescribed in Chapter 12 of the "Recommendations on the Transport of Dangerous Goods" prepared by the United Nations Committee of Experts on the Transport of Dangerous Goods, or other requirements at least equivalent to those standards, and are capable of withstanding a test pressure of 265 kPa (2.65 kgf/cm^2); and

(c) They shall be designed so that any additional shielding which is provided shall be capable of withstanding the static and dynamic stresses resulting from normal handling and routine conditions of transport and of preventing a loss of shielding which would result in more than a 20% increase in the **radiation level** at any external surface of the tank containers.

522. **Tanks**, other than tank containers, may also be used as **industrial package Types 2 and 3 (IP-2)** and **(IP-3)** for transporting **LSA-I** and **LSA-II** liquids and gases as prescribed in Table V, provided that they conform to standards at least equivalent to those prescribed in para. 521.

523. **Freight containers** may also be used as **industrial packages Types 2 or 3, (IP-2) and (IP-3)**, provided that:

(a) They shall satisfy the requirements for **IP-1** specified in para. 518; and

(b) They shall be designed to conform to the requirements prescribed in the International Organization for Standardization document ISO 1496/1-1978, "Series 1 Freight Containers – Specifications and Testing – Part 1: General Cargo Containers", and if they were subjected to the tests prescribed in that document they would prevent loss of shielding which would result in more than a 20% increase in the **radiation level** at any external surface of the **freight containers.**

REQUIREMENTS FOR TYPE A PACKAGES

524. **Type A packages** shall be designed to meet the requirements specified in paras 505–514 and, in addition, the requirements of paras 515–517 if carried by air, and of paras 525–540.

525. The smallest overall external dimension of the **package** shall not be less than 10 cm.

526. The outside of the **package** shall incorporate a feature such as a seal, which is not readily breakable and which, while intact, will be evidence that it has not been opened.

527. Any tie-down attachments on the **package** shall be so designed that, under both normal and accident conditions, the forces in those attachments shall not impair the ability of the **package** to meet the requirements of the Regulations.

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528. The design of the **package** shall take into account temperatures ranging from −40°C to 70°C for the components of the **packaging**. Special attention shall be given to freezing temperatures for liquid contents and to the potential degradation of **packaging** materials within the given temperature range.

529. The **design**, fabrication and manufacturing techniques shall be in accordance with national or international standards, or other requirements, acceptable to the **competent authority**.

530. The **design** shall include a **containment system** securely closed by a positive fastening device which cannot be opened unintentionally or by a pressure which may arise within the **package**.

531. **Special form radioactive material** may be considered as a component of the **containment system**.

532. If the **containment system** forms a separate unit of the **package**, it shall be capable of being securely closed by a positive fastening device which is independent of any other part of the **packaging**.

533. The **design** of any component of the **containment system** shall take into account, where applicable, the radiolytic decomposition of liquids and other vulnerable materials and the generation of gas by chemical reaction and radiolysis.

534. The **containment system** shall retain its **radioactive contents** under a reduction of ambient pressure to 25 kPa (0.25 kgf/cm^2).

535. All valves, other than pressure relief valves, shall be provided with an enclosure to retain any leakage from the valve.

536. A radiation shield which encloses a component of the **package** specified as a part of the **containment system** shall be so designed as to prevent the unintentional release of that component from the shield. Where the radiation shield and such component within it form a separate unit, the radiation shield shall be capable of being securely closed by a positive fastening device which is independent of any other **packaging** structure.

537. A **package** shall be so designed that if it were subjected to the tests specified in paras 619–624, it would prevent:

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

538. The **design** of a **package** intended for liquid **radioactive material** shall make provision for ullage to accommodate variations in the temperature of the contents, dynamic effects and filling dynamics.

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) For **packages** in which the liquid volume does not exceed 50 mL, 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; and
(c) For **packages** in which the liquid volume is greater than 50 mL, either:
    (i) be provided with sufficient absorbent material as prescribed in subpara. 539(b); 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 subparas 539(b) and (c) 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-

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TABLE XII. INSOLATION DATA

Form and location of surface	Insolation for 12 hours per day (W/m^2)
Flat surfaces transported horizontally:	
– base	none
– other surfaces	800
Flat surfaces not transported horizontally:	
– each surface	200[a]
Curved surfaces	400[a]

[a] Alternatively, a sine function may be used, with an absorption coefficient adopted and the effects of possible reflection from neighbouring objects neglected.

strated by the tests in paras 619–624, adversely affect the **package** in such a way that it would fail to meet the applicable requirements for containment and shielding if left unattended for a period of one week. Particular attention shall be paid to the effects of heat, which may:

(a) Alter the arrangement, the geometrical form or the physical state of the **radioactive contents** or, if the **radioactive material** is enclosed in a can or receptacle (for example, clad fuel elements), cause the can, receptacle or **radioactive material** to deform or melt; or
(b) Lessen the efficiency of the **packaging** through differential thermal expansion or cracking or melting of the radiation shielding material; or
(c) In combination with moisture, accelerate corrosion.

544. Except as required in para. 515 for a **package** transported by air, a **package** shall be so designed that, under the ambient condition specified in para. 545, the temperature of the accessible surfaces of a **package** shall not exceed 50°C, unless the **package** is transported under **exclusive use**.

545. In applying paras 543 and 544, the ambient temperature shall be assumed to be 38°C.

546. In applying para. 543, the solar insolation conditions shall be assumed to be as specified in Table XII.

547. A **package** which includes thermal protection for the purpose of satisfying the requirements of the thermal test specified in para.628 shall be so designed that such protection will remain effective if the **package** is subjected to the tests specified in paras 619–624 and 627(a) and (b) or 627(b) and (c), as appropriate. Any such protection on the exterior of the **package** shall not

be rendered ineffective by conditions likely to be encountered in routine handling or transport, or in accidents, and which are not simulated in the tests referred to above, e.g. by ripping, cutting, skidding, abrasion, or rough handling.

548. A **package** shall be so designed that, if it were subjected to:

(a) The tests specified in paras 619–624, it would restrict the loss of **radioactive contents** to not more than 10^{-6} A_2 per hour, and
(b) The tests specified in paras 626, 627(b), 628 and 629 and the test in paras

(i) 627(c), when the **package** has a mass not greater than 500 kg, an overall density not greater than 1000 kg/m^3 based on the external dimensions, and **radioactive contents** greater than 1000 A_2 not as **special form radioactive material**, or
(ii) 627(a), for all other **packages**,

it would restrict the accumulated loss of **radioactive contents** in a period of one week to not more than 10 A_2 for krypton-85 and not more than A_2 for all other radionuclides.

Where mixtures of different radionuclides are present, the provisions of paras 304–306 shall apply except that for krypton-85 an effective A_2 value equal to 100 TBq (2000 Ci) may be used. For case (b) above, the evaluation shall take into account the external contamination limitations of paras 408 and 409.

Requirements for Type B(U) packages

549. **Type B(U) packages** shall meet the requirements for **Type B packages** specified in paras 541–548, and the requirements specified in paras 550–556.

550. A **package** for irradiated nuclear fuel with activity greater than 37 PBq (10^6 Ci) shall be so designed that if it were subjected to the water immersion test specified in para. 630, there would be no rupture of the **containment system**.

551. Compliance with the permitted activity release limits shall depend neither upon filters nor upon a mechanical cooling system.

552. A **package** shall not include a pressure relief system from the **containment system** which would allow the release of **radioactive material** to the environment under the conditions of the tests specified in paras 619–624 and 626–629.

553. A **package** shall be so designed that if it were at the **maximum normal operating pressure** and it were subjected to the tests specified in paras 619–624 and 626–629, the level of strains in the **containment system** would not attain values which would adversely affect the **package** in such a way that it would fail to meet the applicable requirements.

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554. A **package** shall not have a **maximum normal operating pressure** in excess of a gauge pressure of 700 kPa (7 kgf/cm^2).

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 normal conditions of transport. 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 XIII. LIMITATIONS ON HOMOGENEOUS HYDROGENOUS SOLUTIONS OR MIXTURES OF FISSILE MATERIAL

Parameters	Uranium-235 only	Any other fissile material (including mixtures)
Minimum H/X[a]	5200	5200
Maximum concentration of fissile material (g/L)	5	5
Maximum mass of fissile material in a package or conveyance (g)	800[b]	500

[a] Where H/X is the ratio of the number of hydrogen atoms to the number of atoms of fissile nuclide.

[b] With a total plutonium and uranium-233 content of not more than 1% of the mass of uranium-235.

(b) **Packages** containing homogeneous hydrogenous solutions or mixtures satisfying the conditions listed in Table XIII. For unpackaged material, the quantity limitations in Table XIII shall apply to the **consignment** being carried in or on the **conveyance**.

(c) **Packages** containing uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the **fissile material** is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide, or carbide forms, it shall not form a lattice arrangement within the **package**.

(d) **Packages** containing not more than 5 g of **fissile material** in any 10 litre volume, provided that the **radioactive material** is contained in **packages** which will maintain the limitations on **fissile material** distribution under conditions likely to be encountered during routine transport.

(e) **Packages** containing individually not more than 1 kg of total plutonium, of which not more than 20% by mass may consist of plutonium-239, plutonium-241, or any combination of those radionuclides.

(f) **Packages** containing liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-233 content not exceeding 0.1% of the mass of uranium-235, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.

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561. **Packages** containing **fissile material** shall be transported and stored in accordance with the relevant controls in Section IV.

562. **Fissile material** shall be packaged and shipped in such a manner that subcriticality is maintained under conditions likely to be encountered during normal conditions of transport and in accidents. The following contingencies shall be considered:

(a) Water leaking into or out of **packages**;
(b) The loss of efficiency of built-in neutron absorbers or moderators;
(c) Possible rearrangement of the **radioactive contents** either within the **package** or as a result of loss from the **package**;
(d) Reduction of spaces between **packages** or **radioactive contents**;
(e) **Packages** becoming immersed in water or buried in snow; and
(f) Possible effects of temperature changes.

563. A **packaging** for **fissile material** shall be so designed that, if it were subjected to the tests specified in paras 619–624:

(a) Neither the volume nor any spacing on the basis of which nuclear criticality control for the purpose of para. 567(a) has been assessed would suffer more than 5% reduction, and the construction of the **packaging** would prevent the entry of a 10 cm cube; and
(b) Water would not leak into or out of any part of the **package** unless water in-leakage or out-leakage, to the optimum foreseeable extent, has been assumed for the purposes of paras 566 and 567; and
(c) The configuration of the **radioactive contents** and the geometry of the **containment system** would not be altered so as to increase the neutron multiplication significantly.

Undamaged and damaged packages

564. For the purposes of the evaluation in this subsection:

(a) Undamaged shall mean the condition of the **package** as it is designed to be presented for transport;
(b) Damaged shall mean the evaluated or demonstrated condition of the **package** if it had been subjected to whichever of the following combination of tests is the more limiting:

(i) The tests specified in paras 619–624 followed by the tests specified in paras 626–628 and completed by the tests specified in paras 631–633. The mechanical test of para. 627 shall be that required by para. 548.
(ii) The tests specified in paras 619–624 followed by the test in para. 629.

Individual packages in isolation

565. In determining the subcriticality of individual **packages** in isolation, it shall be assumed that water can leak into or out of all void spaces of the **package**, including those within the **containment system**. However, if the **design** incorporates special features to prevent such leakage of water into or out of certain void spaces, even as a result of human error, absence of leakage may be assumed in respect of those void spaces. Special features shall include the following:

(a) Multiple high standard water barriers, each of which would remain leaktight if the **package** were damaged (see para. 564); a high degree of quality control in the production and maintenance of **packagings**; and special tests to demonstrate the closure of each **package** before **shipment**; or
(b) Other features given **multilateral approval.**

566. The individual **package** damaged or undamaged shall be subcritical under the conditions specified in paras 564 and 565, taking into account the physical and chemical characteristics including any change in those characteristics which would occur when the **package** is damaged and with the conditions of moderation and reflection as specified below:

(a) For the material within the **containment system**: the material arranged in the **containment system**
    (i) In the configuration and moderation that results in maximum neutron multiplication; and
    (ii) With close reflection of the **containment system** by water 20 cm thick (or equivalent) or such greater reflection of the **containment system** as may additionally be provided by the surrounding material of the **packaging**; and, in addition
(b) If any part of the material escapes from the **containment system**: that material arranged in
    (i) The configuration and moderation that results in maximum neutron multiplication; and
    (ii) With close reflection of that material by water 20 cm thick (or equivalent).

Arrays of packages

567. An array of **packages** shall be subcritical. A number 'N' shall be derived assuming that if **packages** were stacked together in any arrangement with the stack closely reflected on all sides by water 20 cm thick (or its equivalent) both of the following conditions would be satisfied:

(a) Five times 'N' would be subc
(b) Two times 'N' **packages** to th would be subcr

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    (ii) If its neutr shall be reg maximum r
(c) For unspecified composition, ma known or cannot mining subcritica which gives the n of transport.

(a) Five times 'N' undamaged **packages** without anything between the **packages** would be subcritical; and

(b) Two times 'N' damaged **packages** with hydrogenous moderation between **packages** to the extent which results in the greatest neutron multiplication would be subcritical.

Subcriticality evaluation assumptions

568. In evaluating the subcriticality of **fissile material** in its transport configuration, the following shall apply:

(a) The determination of subcriticality for irradiated **fissile material** may be based on the actual irradiation experience, taking into account significant variations in composition;

(b) For irradiated **fissile material** of unknown irradiation experience the following assumptions shall be made in determining subcriticality:

  (i) If its neutron multiplication decreases with irradiation, the material shall be regarded as unirradiated;

  (ii) If its neutron multiplication increases with irradiation, the material shall be regarded as irradiated to the point corresponding to the maximum neutron multiplication; and

(c) For unspecified **fissile material**, such as residues or scrap, whose fissile composition, mass, concentration, moderation ratio or density is not known or cannot be identified, the assumption shall be made in determining subcriticality that each parameter that is not known has the value which gives the maximum neutron multiplication under credible conditions of transport.

SECTION VI

TEST PROCEDURES

DEMONSTRATION OF COMPLIANCE

601. Demonstration of compliance with the performance standards required in Section V shall be accomplished by any of the methods listed below or by a combination thereof.

(a) Performance of tests with specimens representing LSA-III, special form radioactive material (solid radioactive material or capsules), or with prototypes or samples of the packaging, where the contents of the specimen or the packaging for the tests shall simulate as closely as practicable the expected range of radioactive contents and the specimen or packaging to be tested shall be prepared as normally presented for transport.

(b) Reference to previous satisfactory demonstrations of a sufficiently similar nature.

(c) Performance of tests with models of appropriate scale incorporating those features which are significant with respect to the item under investigation when engineering experience has shown the results of such tests to be suitable for design purposes. When a scale model is used, the need for adjusting certain test parameters, such as penetrator diameter or compressive load, shall be taken into account.

(d) Calculation, or reasoned argument, when the calculation procedures and parameters are generally agreed to be reliable or conservative

602. After the specimen, prototype or sample has been subjected to the tests, appropriate methods of assessment shall be used to assure that the requirements of this section have been fulfilled in conformance with the performance and acceptance standards prescribed in Section V.

TEST FOR LSA-III MATERIAL

603. Solid material representing no less than the entire contents of the package shall be immersed for 7 days in water at ambient temperature. The volume of water to be used in the test shall be sufficient to ensure that at the end of the 7 day test period the free volume of the unabsorbed and unreacted water remaining shall be at least 10% of the volume of the solid test sample itself. The water shall have an initial pH of 6–8 and a maximum conductivity of 1 mS/m (10 μmho/cm) at 20°C. The total activity of the free volume of water shall be measured following the 7 day immersion of the test sample.

TESTS FOR SPECIAL FORM RADIOACTIVE MATERIAL

General

604. The tests which shall be performed on specimens that comprise or simulate **special form radioactive material** are: the impact test, the percussion test, the bending test, and the heat test.

605. A different specimen may be used for each of the tests.

606. After each test specified in paras 607–611, a leaching assessment or volumetric leakage test shall be performed on the specimen by a method no less sensitive than the methods given in para. 612 for indispersible solid material and para. 613 for encapsulated material.

Test methods

607. *Impact test.* The specimen shall drop onto the target from a height of 9 m. The target shall be as defined in para. 618.

608. *Percussion test.* The specimen shall be placed on a sheet of lead which is supported by a smooth solid surface and struck by the flat face of a steel billet so as to produce an impact equivalent to that resulting from a free drop of 1.4 kg through 1 m. The flat face of the billet shall be 25 mm in diameter with the edges rounded off to a radius of (3.0 ± 0.3) mm. The lead, of hardness number 3.5 to 4.5 on the Vickers scale and not more than 25 mm thick, shall cover an area greater than that covered by the specimen. A fresh surface of lead shall be used for each impact. The billet shall strike the specimen so as to cause maximum damage.

609. *Bending test.* The test shall apply only to long, slender sources with both a minimum length of 10 cm and a length to minimum width ratio of not less than 10. The specimen shall be rigidly clamped in a horizontal position so that one half of its length protrudes from the face of the clamp. The orientation of the specimen shall be such that the specimen will suffer maximum damage when its free end is struck by the flat face of a steel billet. The billet shall strike the specimen so as to produce an impact equivalent to that resulting from a free vertical drop of 1.4 kg through 1 m. The flat face of the billet shall be 25 mm in diameter with the edges rounded off to a radius of (3.0 ± 0.3) mm.

610. *Heat test* The specimen shall be heated in air to a temperature of 800°C and held at that temperature for a period of 10 minutes and shall then be allowed to cool.

611. Specimens that comprise or simulate radioactive material enclosed in a sealed capsule may be excepted from:

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(a) The tests prescribed in paras 607 and 608 provided they are alternatively subjected to the Class 4 impact test prescribed in the International Organization for Standardization document ISO 2919-1980(E), "Sealed radioactive sources – Classification", and

(b) The test prescribed in para. 610 provided they are alternatively subjected to the Class 6 temperature test specified in the International Organization for Standardization document ISO 2919-1980(E), "Sealed radioactive sources – Classification".

Leaching and volumetric leakage assessment methods

612. For specimens which comprise or simulate indispersible solid material, a leaching assessment shall be performed as follows:

(a) The specimen shall be immersed for 7 days in water at ambient temperature. The volume of water to be used in the test shall be sufficient to ensure that at the end of the 7 day test period the free volume of the unabsorbed and unreacted water remaining shall be at least 10% of the volume of the solid test sample itself. The water shall have an initial pH of 6–8 and a maximum conductivity of 1 mS/m (10 μmho/cm) at 20°C.

(b) The water with specimen shall then be heated to a temperature of (50 ± 5)°C and maintained at this temperature for 4 hours.

(c) The activity of the water shall then be determined.

(d) The specimen shall then be stored for at least 7 days in still air of relative humidity not less than 90% at 30°C.

(e) The specimen shall then be immersed in water of the same specification as in (a) above and the water with the specimen heated to (50 ± 5)°C and maintained at this temperature for 4 hours.

(f) The activity of the water shall then be determined.

613. For specimens which comprise or simulate radioactive material enclosed in a sealed capsule, either a leaching assessment or a volumetric leakage assessment shall be performed as follows:

(a) The leaching assessment shall consist of the following steps:

(i) The specimen shall be immersed in water at ambient temperature. The water shall have an initial pH of 6–8 with a maximum conductivity of 1 mS/m (10 μmho/cm) at 20°C.

(ii) The water and specimen shall be heated to a temperature of (50 ± 5)°C and maintained at this temperature for 4 hours.

(iii) The activity of the water shall then be determined.

(iv) The specimen shall then be stored for at least 7 days in still air at a temperature of not less than 30°C.

(v) The process in (i), (ii) and (iii) shall be repeated.

(b) The alternative volumetric leakage assessment shall comprise any of the tests prescribed in the International Organization for Standardization document ISO/TR 4826-1979(E), "Sealed radioactive sources – Leak test methods", which are acceptable to the competent authority.

TESTS FOR PACKAGES

Preparation of a specimen for testing

614. All specimens shall be examined before testing in order to identify and record faults or damage including the following:

(a) divergence from the design;
(b) defects in construction;
(c) corrosion or other deterioration; and
(d) distortion of features.

615. The containment system of the package shall be clearly specified.

616. The external features of the specimen shall be clearly identified so that reference may be made simply and clearly to any part of such specimen.

Testing the integrity of the containment system and shielding

617. After the applicable tests specified in paras 619–633:

(a) Faults and damage shall be identified and recorded;
(b) It shall be determined whether the integrity of the containment system and shielding has been retained to the extent required in Section V for the packaging under test; and
(c) For packages containing fissile material, it shall be determined whether the assumptions made in paras 562–567 regarding the most reactive configuration and degree of moderation of the fissile contents, of any escaped material, and of one or more packages are valid.

Target for drop tests

618. The target for the drop tests specified in paras 607, 622, 625(a) and 627 shall be a flat, horizontal surface of such a character that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

TABLE XIV. FREE DROP DISTANCE FOR TESTING PACKAGES TO NORMAL CONDITIONS OF TRANSPORT

Package mass (kg)	Free drop distance (m)
package mass < 5 000	1.2
5 000 ≤ package mass < 10 000	0.9
10 000 ≤ package mass < 15 000	0.6
15 000 ≤ package mass	0 3

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.

(b) For packages containing fissile material the free drop test specified above shall be preceded by a free drop from a height of 0.3 m on each corner or, in the case of a cylindrical package, onto each of the quarters of each rim.
(c) For rectangular fibreboard or wood packages not exceeding a mass of 50 kg, a separate specimen shall be subjected to a free drop onto each corner from a height of 0.3 m.
(d) For cylindrical fibreboard packages not exceeding a mass of 100 kg, a separate specimen shall be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 m.

623. *Stacking test.* Unless the shape of the packaging effectively prevents stacking, the specimen shall be subjected, for a period of 24 h, to a compressive load equal to the greater of the following:

(a) The equivalent of 5 times the mass of the actual package; and
(b) The equivalent of 13 kPa (0.13 kgf/cm^2) multiplied by the vertically projected area of the package.

The load shall be applied uniformly to two opposite sides of the specimen, one of which shall be the base on which the package would normally rest.

624. *Penetration test.* The specimen shall be placed on a rigid, flat, horizontal surface which will not move significantly while the test is being carried out.

(a) A bar of 3.2 cm in diameter with a hemispherical end and a mass of 6 kg shall be dropped and directed to fall, with its longitudinal axis vertical, onto the centre of the weakest part of the specimen, so that, if it penetrates sufficiently far, it will hit the containment system. The bar shall not be significantly deformed by the test performance.
(b) The height of drop of the bar measured from its lower end to the intended point of impact on the upper surface of the specimen shall be 1 m.

Additional tests for Type A packages designed for liquids and gases

625. A specimen or separate specimens shall be subjected to each of the following tests unless it can be demonstrated that one test is more severe for the specimen in question than the other, in which case one specimen shall be subjected to the more severe test.

(a) *Free drop test.* The specimen shall drop onto the target so as to suffer the maximum damage in respect of containment. The height of the drop measured from the lowest part of the specimen to the upper surface of the target shall be 9 m. The target shall be as defined in para. 618.
(b) *Penetration test.* The specimen shall be subjected to the test specified in para. 624 except that the height of drop shall be increased to 1.7 m from the 1 m specified in para. 624(b).

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Tests for demonstrating ability to withstand accident conditions in transport

626. The specimen shall be subjected to the cumulative effects of the tests specified in para. 627 and para. 628, in that order. Following these tests, either this specimen or a separate specimen shall be subjected to the effect(s) of the water immersion test(s) as specified in para. 629 and, if applicable, para. 630.

627. *Mechanical test.* The mechanical test consists of three different drop tests. Each specimen shall be subjected to the applicable drops as specified in para. 548. The order in which the specimen is subjected to the drops shall be such that, on completion of the mechanical test, the specimen shall have suffered such damage as will lead to the maximum damage in the thermal test which follows.

(a) For drop I, the specimen shall be dropped onto the target so as to suffer the maximum damage, and the height of the drop measured from the lowest point of the specimen to the upper surface of the target shall be 9 m. The target shall be as defined in para. 618.

(b) For drop II, the specimen shall be dropped so as to suffer the maximum damage onto a bar rigidly mounted perpendicularly on the target. The height of the drop measured from the intended point of impact of the specimen to the upper suface of the bar shall be 1 m. The bar shall be of solid mild steel of circular section, (15.0 ± 0.5) cm in diameter, and 20 cm long unless a longer bar would cause greater damage, in which case a bar of sufficient length to cause maximum damage shall be used. The upper end of the bar shall be flat and horizontal with its edges rounded off to a radius of not more than 6 mm. The target on which the bar is mounted shall be as described in para. 618.

(c) For drop III, the specimen shall be subjected to a dynamic crush test by positioning the specimen on the target so as to suffer maximum damage by the drop of a 500 kg mass from 9 m onto the specimen. The mass shall consist of a solid mild steel plate 1 m by 1 m and shall fall in a horizontal attitude. The height of the drop shall be measured from the underside of the plate to the highest point of the specimen. The target on which the specimen rests shall be as defined in para. 618.

628. *Thermal test.* The thermal test shall consist of the exposure of a specimen fully engulfed, except for a simple support system, in a hydrocarbon fuel/air fire of sufficient extent and in sufficiently quiescent ambient conditions to provide an average emissivity coefficient of at least 0.9, with an average flame temperature of at least 800°C for a period of 30 minutes, or shall be any other thermal test which provides the equivalent total heat input to the package. The fuel source shall extend horizontally at least 1 m, and shall not extend more than 3 m, beyond any external surface of the specimen, and the specimen shall be positioned 1 m above the surface of the fuel source. After the cessation of external heat input,

the specimen shall not be cooled artificially and any combustion of materials of the specimen shall be allowed to proceed naturally. For demonstration purposes, the surface absorptivity coefficient shall be either 0.8 or that value which the package may be demonstrated to possess if exposed to the fire specified; and the convective coefficient shall be that value which the designer can justify if the package were exposed to the fire specified. With respect to the initial conditions for the thermal test, the demonstration of compliance shall be based upon the assumption that the package is in equilibrium at an ambient temperature of 38°C. The effects of solar radiation may be neglected prior to and during the tests, but must be taken into account in the subsequent evaluation of the package response.

629. *Water immersion test.* The specimen shall be immersed under a head of water of at least 15 m for a period of not less than eight hours in the attitude which will lead to maximum damage. For demonstration purposes, an external gauge pressure of at least 150 kPa (1.5 kgf/cm^2) shall be considered to meet these conditions.

Water immersion test for packages containing irradiated nuclear fuel

630. The specimen shall be immersed under a head of water of at least 200 m for a period of not less than one hour. For demonstration purposes, an external gauge pressure of at least 2 MPa (20 kgf/cm^2) shall be considered to meet these conditions.

Water leakage test for packages containing fissile material

631. Packages for which water in-leakage or out-leakage to the extent which results in greatest reactivity has been assumed for purposes of assessment under paras 564–567 shall be excepted from the test.

632. Before the specimen is subjected to the water leakage test specified below, it shall be subjected to the tests in para. 627(b), and either para. 627(a) or (c) as required by para. 548, and the test specified in para. 628.

633. The specimen shall be immersed under a head of water of at least 0.9 m for a period of not less than eight hours and in the attitude for which maximum leakage is expected.

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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; and
(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.

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/cm^2) 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**; and
(h) A reproducible illustration not larger than 21 cm by 30 cm showing the make-up of the **package**.

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;

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(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.

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 1990.

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

construction begins after 31 December 1995 meet the 1985 Edition of the Regulations in full.

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 3×10^3 A_1 or 3×10^3 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.**

721. An application for approval of a shipment under special arrangement shall include all the information necessary to satisfy the competent authority that the overall level of safety in transport is at least equivalent to that which would be provided if all the applicable requirements of the Regulations had been met. The application shall also include:

(a) A statement of the respects in which, and of the reasons why, the consignment cannot be made in full accordance with the applicable requirements; and

(b) A statement of any special precautions or special administrative or operational controls which are to be employed during transport to compensate for the failure to meet the applicable requirements.

722. Upon approval of a shipment under special arrangement, the competent authority shall issue an approval certificate.

COMPETENT AUTHORITY APPROVAL CERTIFICATES

723. Four types of approval certificates may be issued: special form radioactive material, special arrangement, shipment and package design. The package design and shipment approval certificates may be combined into a single certificate.

Competent authority identification marks

724. Each approval certificate issued by a competent authority shall be assigned an identification mark. The mark shall be of the following generalized type:

VRI/Number/Type code

(a) VRI represents the international vehicle registration identification code of the country issuing the certificate.

(b) The number shall be assigned by the competent authority, and shall be unique and specific with regard to the particular design or shipment. The shipment approval identification mark shall be clearly related to the design approval identification mark.

(c) The following type codes shall be used in the order listed to indicate the types of approval certificates issued:

AF	Type A package design for fissile material
B(U)	Type B(U) package design [B(U)F if for fissile material]
B(M)	Type B(M) package design [B(M)F if for fissile material]
IF	Industrial package design for fissile material
S	Special form radioactive material
T	Shipment
X	Special arrangement.

(d) For package design approval certificates, other than those issued under the provisions of paras 713 or 714, the symbols '-85' shall be added to the type code of the package design.

725. These type codes shall be applied as follows:

(a) Each certificate and each package shall bear the appropriate identification mark, comprising the symbols prescribed in para. 724(a), (b), (c) and (d) above, except that, for packages, only the applicable design type codes including, if applicable, the symbols '-85', shall appear following the second stroke, that is, the 'T' or 'X' shall not appear in the identification marking on the package. Where the design approval and shipment approval are combined, the applicable type codes do not need to be repeated. For example:

A/132/B(M)F-85: A Type B(M) package design approved for fissile material, requiring multilateral approval, for which the competent authority of Austria has assigned the design number 132 (to be marked on both the package and on the package design approval certificate);

A/132/B(M)F-85T: The shipment approval issued for a package bearing the identification mark elaborated above (to be marked on the certificate only);

A/137/X-85: A special arrangement approval issued by the competent authority of Austria, to which the number 137 has been assigned (to be marked on the certificate only);

A/139/IF-85: An industrial package design for fissile material approved by the competent authority of Austria, to which package design number 139 has been assigned (to be marked on both the package and on the package design approval certificate).

(b) Where multilateral approval is effected by validation, only the identification mark issued by the country of origin of the design or shipment shall be used. Where multilateral approval is effected by issue of certificates by successive countries, each certificate shall bear the appropriate mark and the package whose design was so approved shall bear all appropriate identification marks. For example:

A/132/B(M)F-85
CH/28/B(M)F-85

would be the identification mark of a package which was originally approved by Austria and was subsequently approved, by separate certificate, by Switzerland. Additional identification marks would be tabulated in a similar manner on the package.

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.

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).

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) If deemed appropriate by the competent authority, reference to the identity of the applicant.
(j) Signature and identification of the certifying official.

Special arrangement approval certificates

727. Each approval certificate issued by a **competent authority** for a **special arrangement** shall include the following information:

(a) Type of certificate.
(b) The **competent authority** identification mark.
(c) The issue date and an expiry date.
(d) Mode(s) of transport.
(e) Any restrictions on the modes of transport, type of **conveyance**, **freight container**, and any necessary routing instructions.
(f) 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 arrangement** is approved.
(g) 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."

(h) References to certificates for alternative **radioactive contents**, other **competent authority** validation, or additional technical data or information, as deemed appropriate by the **competent authority**.
(i) Description of the **packaging** by a reference to the drawings or a 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.
(j) A brief specification of the authorized **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 activities involved (including those of the various isotopes, if appropriate), amounts in grams (for **fissile material**), and whether **special form radioactive material**.
(k) Additionally, for **package designs** for **fissile material**:

(i) a detailed description of the authorized **radioactive contents**;
(ii) the value of the **transport index** for nuclear criticality control;
(iii) any special features, on the basis of which the absence of water from certain void spaces has been assumed in the criticality assessment; and
(iv) any determination (based on para. 568(a)) on which decreased neutron multiplication is assumed in the criticality assessment as a result of actual irradiation experience.

(l) 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.

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

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

(m) 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 **comptent 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

appropriate), amounts in grams (for **fissile material**), and whether **special form radioactive material**.

(m) Additionally, for **packages** for **fissile material**:

(i) A detailed description of the authorized **radioactive contents**;
(ii) The value of the **transport index** for nuclear criticality control;
(iii) Any special features, on the basis of which the absence of water from certain void spaces has been assumed in the criticality assessment; and
(iv) Any determination (based on para. 568(a)) on which decreased neutron multiplication is assumed in the criticality assessment as a result of actual irradiation experience.

(n) For **Type B(M) packages**, a statement specifying those prescriptions of paras. 550–556 with which the **package** does not conform and any amplifying information which may be useful to other **competent authorities**.

(o) 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.

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

(q) 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.

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

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

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

(u) Signature and identification of the certifying official.

VALIDATION OF CERTIFICATES

730. **Multilateral approval** may be by validation of the original certificate issued by the **competent authority** of the country of origin of the **design** or **shipment**. Such validation may take the form of an endorsement on the original certificate or the issuance of a separate endorsement, annex, supplement, etc., by the **competent authority** of the country through or into which the **shipment** is made.

Appendix I

EXCERPTS FROM LIST OF UNITED NATIONS NUMBERS, PROPER SHIPPING NAME AND DESCRIPTION AND SUBSIDIARY RISKS

Number	Name and description	Subsidiary risks
2910	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, – INSTRUMENTS or ARTICLES, – LIMITED QUANTITY OF MATERIAL, – ARTICLES MANUFACTURED FROM NATURAL URANIUM or DEPLETED URANIUM or NATURAL THORIUM, – EMPTY PACKAGING	
2912	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA), N.O.S.[a]	
2913	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO)	
2918	RADIOACTIVE MATERIAL, FISSILE, N.O.S.[a]	
2974	RADIOACTIVE MATERIAL, SPECIAL FORM, N.O.S.[a]	
2975	THORIUM METAL, PYROPHORIC	Liable to spontaneous combustion
2976	THORIUM NITRATE, SOLID	Oxidizing substance
2977	URANIUM HEXAFLUORIDE, FISSILE containing more than 1.0 per cent uranium-235	Corrosive
2978	URANIUM HEXAFLUORIDE, fissile excepted or non-fissile	Corrosive
2979	URANIUM METAL, PYROPHORIC	Liable to spontaneous combustion
2980	URANYL NITRATE HEXAHYDRATE SOLUTION	Corrosive
2981	URANYL NITRATE, SOLID	Oxidizing substance
2982	RADIOACTIVE MATERIAL, N.O.S.[a]	

[a] N.O.S. – not otherwise specified.

CONVERSION FACTORS AND PREFIXES

This edition of the Regulations for the Safe Transport of Radioactive Materials uses, as primary units, the International System of Units (SI). In some cases however, subsidiary units which have been traditionally used are shown in parentheses following the primary units to assist users. As a result, the values which are controlling are those with SI units; the values with subsidiary units are only approximations thereof. The conversion factors for the dually specified units are:

RADIATION UNITS

Activity in becquerel (Bq) or curie (Ci)

$1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$

Dose equivalent in sievert (Sv) or rem

$1 \text{ rem} = 1.0 \times 10^{-2} \text{ Sv}$

PRESSURE

Pressure in pascal (Pa) or (kgf/cm^2)

$1 \text{ kgf/cm}^2 = 9.806 \times 10^4 \text{ Pa}$

CONDUCTIVITY

Conductivity in siemens per metre (S/m) or (mho/cm)

$10 \, \mu\text{mho/cm} = 1 \text{ mS/m}$

or

$1 \text{ mho/cm} = 100 \text{ S/m}$

SI PREFIXES

The prefixes to be used with the SI units are:

Multiplying factor	Prefix	Symbol
$1\,000\,000\,000\,000\,000\,000 = 10^{18}$	exa	E
$1\,000\,000\,000\,000\,000 = 10^{15}$	peta	P
$1\,000\,000\,000\,000 = 10^{12}$	tera	T
$1\,000\,000\,000 = 10^{9}$	giga	G
$1\,000\,000 = 10^{6}$	mega	M
$1\,000 = 10^{3}$	kilo	k
$100 = 10^{2}$	hecto	h
$10 = 10^{1}$	deka	da
$0.1 = 10^{-1}$	deci	d
$0.01 = 10^{-2}$	centi	c
$0.001 = 10^{-3}$	milli	m
$0\,000\,001 = 10^{-6}$	micro	μ
$0.000\,000\,001 = 10^{-9}$	nano	n
$0.000\,000\,000\,001 = 10^{-12}$	pico	p
$0.000\,000\,000\,000\,001 = 10^{-15}$	femto	f
$0.000\,000\,000\,000\,000\,001 = 10^{-18}$	atto	a

LIST OF MEETINGS RELATING TO THE 1985 EDITION OF SAFETY SERIES No.6 AND OF PARTICIPANTS AT THOSE MEETINGS

Following advice from the first meeting of the Standing Advisory Group on the Safe Transport of Radioactive Materials (SAGSTRAM) held in October 1978, and utilizing technical advice from various Advisory Group and Technical Committee meetings, the Agency initiated a comprehensive review and revision of Safety Series No. 6 in September 1980. The revision process was monitored closely by the second and third SAGSTRAM meetings held in March/April 1980 and October 1981, and culminated with the endorsement of the draft revision by the fourth meeting of SAGSTRAM in February/March 1984. Those meetings which contributed directly to the 1985 Edition of Safety Series No 6 are

AG-366	Advisory Group for the Comprehensive Review of the Agency's Regulations for the Safe Transport of Radioactive Materials, 1–12 September 1980.
TC-405	Technical Committee for the Review of the Nuclear Criticality Safety Aspects of the Agency's Regulations for the Safe Transport of Radioactive Materials, 23–27 March 1981.
TC-406	Technical Committee on Transport Package Test Standards, 28 September – 2 October 1981.
AG-365.2	Second Meeting of the Advisory Group on the Comprehensive Review of the IAEA Regulations for the Safe Transport of Radioactive Materials, 22–26 March 1982.
DC1	Drafting Committee for the Third Draft Revision of Safety Series No. 6, 3–7 May 1982.
SWG	Special Working Group on "Q" System, 31 August – 2 September 1982.
TC-458	Technical Committee on Assuring the Implementation of the Transport Regulations, 22–26 November 1982.
RTSG-12	The Twelfth Meeting of the Radioactive Transport Study Group, 2–4 November 1983.
AG-406	Third Meeting of the Advisory Group on the Comprehensive Review of the IAEA Regulations for the Safe Transport of Radioactive Materials, 7–11 November 1983.
DC2	Drafting Committee for the Fourth Draft Revision of Safety Series No 6, 14–18 November 1983.
CM	Consultants Meeting Addressing Consistency Between Safety Series No 6 and Safety Series No 9, 25–27 January 1984.
TC-407.2	Fourth Meeting of the Standing Advisory Group on the Safe Transport of Radioactive Materials, 28 February – 1 March 1984.

LIST OF MEETINGS AND PARTICIPANTS

Designating Member States or International Organizations and names of Participants	Meeting											
	AG-266	TC-405	TC-406	AG-365.2	DC1	SWG	TC-458	RTSG-12	AG-406	DC2	CM	TC-407.2
ARGENTINA												
Beninson, D.											O	
Biaggio, A.	E	E	E	E					E			E
Canavese, S.I.		O										
AUSTRALIA												
Nelmes, R.F.	E			E				O	E			
Rolland, J.M.	O			O								C, E
AUSTRIA												
Mayer, G.									O			O
Neubauer, J.									O			
Patek, P.	O			E					E			
BELGIUM												
Baekelandt, L.				O		O	E	O	O			
CANADA												
Dicke, G.J.	O			O		O			O			
Eyre, P.									O			
Jack, G.				O		O		O				E
Kotler, J.	O		O	O					O			
McLellan, J.J.	E		E	E					E			
Ridout, E.F.	O		O	O	O		E		O			
Schultz, K.		E		O								
Taylor, W.R.			O						O			
White, M.C.									O	O		
CZECHOSLOVAKIA												
Lukavsky, J.							E		O			

DENMARK												
Jensen, H.	O											
Ulbak, K.	E			E		O			E			
FRANCE												
Blum, P.	O		O	O					O			
Cohendy, G.	O											
Grenier, M.	O	O		O	O	O	E	O	O	O		O
Guenn, C.												O
Hamard, M.	O			O		O			O			
Haon, M.		O										
Leclerc, M.		E		O								
Pult, J.C.				O								
Ringot, C.				O		O			O			
Sousselier, Y.	E		O	O					E			O
Warniez, P.			E	E			O					E
GERMAN DEMOCRATIC REPUBLIC												
Nitsche, F.	O		E	O								
Runge, K.	E			E			E					
GERMANY, FEDERAL REPUBLIC OF												
Collin, F.W.	O			O			E	O	O	O		E
Hübner, H.W.	O		O	O								
Kolb, W.	E			E		O			E			
Körner, R.							O					
Ridder, K.	O			O			O		O			O
Schulz-Forberg, B.							O					
Schweer, H.H.		E										
Thomas, W.		O										
Wehner, G.				O					O			O
Wieser, K.			E						O			
HUNGARY												
Golder, F.	E			E			E		E			

C: Chairman; E: Expert; O: Observer; S: Scientific Secretary

LIST OF MEETINGS AND PARTICIPANTS (cont.)

Designating Member States or International Organizations and names of Participants	Meeting											
	AG-266	TC-405	TC-406	AG-365.2	DC1	SWG	TC-458	RTSG-12	AG-406	DC2	CM	TC-407.2
INDIA												
Bisht, J.S.				E								
Iyer, S.R.												E
Subrahmanian, G.	E								E			
Vohra, K.G.							E					
ITALY												
Falocı, C.						O	E		E			E
Mancıoppi, S.		E		O								
Orsini, A.			O	O			O					O
Piermattei, S.	E		E	E		O			O			
JAPAN												
Akaishaı, J.						O						O
Aoki, S.			O									
Fukuda, S.			O									
Futamura, Y.								O	O			O
Hamaji, K.												
Honda, T.			O									
Ichikawa, S.											O	
Kaneko, Y.		E										
Kikuchi, S.			O									
Kubo, M.				O			O					O
Kuwashima, K.	O		O	O		O			O			
Meguro, T.			O									
Miura, M.			E	E			E					
Nemoto, K.									O			O
Nishimura, H.									O			
Ono, S.			O									
Onodera, A.	O		O	O					O			
Satake, H.	E											
Sekımızu, K.	O											
Seya, M.									O			
Shimada, H.			O									
Shımamura, S.			O									
Shınınichı, S.									O			
Takeda, T.			O									
Yoshimura, S.								O	E			E
NETHERLANDS												

Yoshimura, S.								O	E			E

NETHERLANDS												
Selling, H.A.							E	O	O			E
Zoomer, R.J.			E									
POLAND												
Art, J.												E
Rzymkowski, T.			E									
Zarnowiecki, K.		E										
SPAIN												
Roldan, C.				E								
SWEDEN												
Dufva, B.	O	E						O				
Ek, P.			C, E									
Ericsson, A.M.			O									
Mennerdahl, D.		O										
Persson, A.	O											
Pettersson, B.G.	O		O	E		O	E	C	E	O		E
Svahn, B.				O		O			O			O
SWITZERLAND												
Stalder, F.							E		O			
UNION OF SOVIET SOCIALIST REPUBLICS												
Marvin, A.S.				O								
UNITED KINGDOM												
Blackman, D.J.						O						
Goldfinch, E.P.	O		O	O		O	O		O			
Grover, J.R.									O			O
Leigh, K.M.		O										
Macdonald, H.F.						O						
Marshall, W.		O										
McLean, K.							O					
O'Sullivan, R.	O	E		E	O		C, E	O				E
Partridge, A.H.	E		E	O								
Shaw, K.	O			O		O			O		O	O

C: Chairman; E: Expert; O: Observer; S: Scientific Secretary

LIST OF MEETINGS AND PARTICIPANTS (cont.)

Designating Member States or International Organizations and names of Participants	Meeting											
	AG-266	TC-405	TC-406	AG-365.2	DC1	SWG	TC-458	RTSG-12	AG-406	DC2	CM	TC-407.2
UNITED KINGDOM (cont.)												
Swindell, G.E.								O				
Williamson, S.	O		O	O			O		O			
Wilson, C.K.									O			
Young, C.N.							O	O	E	O		O
UNITED STATES OF AMERICA												
Brobst, W.A.	O			O								
Carlson, R.		O										
Chappel, C.R.	O											
Chitwood, R.	O	O										
Eckermann, K.						O			O			
Falci, F.									O			
Goldmann, K.	O											
Grella, A.W.	O			O								
Hopkins, D.R.	O			O		O						
Johnson, C.R.	O											
Luna, R.E.	O			O								
Page, R.G.									O	O		O
Pope, R.B.			O	O					O			
Rawl, R.R.	C, E	C, E	E	C, E	O	C		O	C, E			E
Thomas, J.T.		O										
Tse, A.N.		O	O									
COMMISSION OF THE EUROPEAN COMMUNITIES												
Celant, E.				O			O					
Cricchio, A.	O											
Marchal, A.				O			O		O			O
Nacfaire, H.	O											
Swindell, G.E.		O	O	O								
ECONOMIC COMMISSION FOR EUROPE												
Gross, J.	O											

INTERNATIONAL AIR												

Gross, J.	O											

INTERNATIONAL AIR TRANSPORT ASSOCIATION Abouchaar, J. Doran, D.		O		O			O		O			O
INTERNATIONAL CARGO HANDLING COORDINATION ASSOCIATION Warburton, J.T.									O			
INTERNATIONAL CIVIL AVIATION ORGANIZATION Cox, J. Mortimer, L.F.				O			O					
INTERNATIONAL FEDERATION OF AIRLINE PILOTS ASSOCIATION Serres, M.							O					
INTERNATIONAL MARITIME ORGANIZATION Wardelmann, H.	O			O		O	O		O			O
INTERNATIONAL ORGANIZATION FOR STANDARDIZATION Kolb, W. Schulz-Forberg, B.							O		O			
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT – NEA Johnson, E. Olivier, J.P. Stevens, M.E.	O	O		O								
UNIVERSAL POSTAL UNION Gueorgvikievski, A.S. Milne, J.M.				O O					O			

C: Chairman; E: Expert; O: Observer; S: Scientific Secretary

LIST OF MEETINGS AND PARTICIPANTS (cont.)

Designating Member States or International Organizations and names of Participants	Meeting											
	AG-266	TC-405	TC-406	AG-365.2	DC1	SWG	TC-458	RTSG-12	AG-406	DC2	CM	TC-407.2
WORLD HEALTH ORGANIZATION												
Komarov, E.				O								
Nandakumar, A.N.									O	O		
INTERNATIONAL ATOMIC ENERGY AGENCY												
Barker, R.F.	S	S	O	O	S	S			O	O	O	O
Bernardo, B.C.	O	O	O	O	O							
Daw, H.T.									O			
González, A.											O	O
Krivanek, M.	O											
Nishiwaki, Y.	O		O									
Pope, R.B.								O	S	S	S	S
Tsyplenkov, V.	O											
White, M.C.	S	O		S	O	O	S		O			

C: Chairman; E: Expert; O: Observer; S: Scientific Secretary

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(by paragraph and table number)

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